

B 836717
MAY 16 1960

THE LIBRARY OF
CONGRESS
SERIAL RECORD

JUN 8 1960

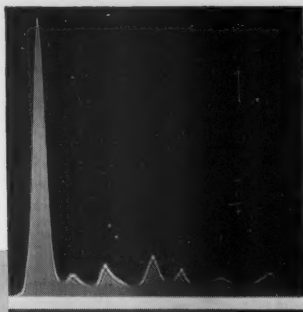
SCIENCE

13 May 1960

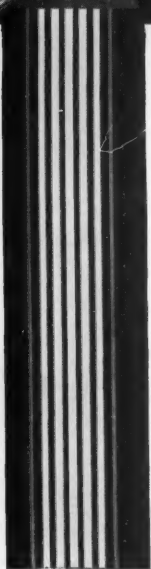
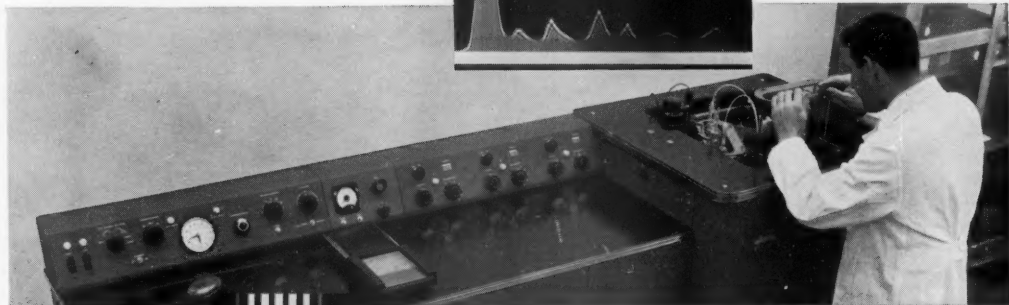
Vol. 131, No. 3411

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE





Electrophoresis of human plasma diluted 1:6; ascending boundaries. Inclined knife-edge schlieren.



Portion of typical reference fringe pattern obtained from standard production model, magnified to show straightness and definition of entire pattern.

ELECTROPHORESIS AND DIFFUSION

in one precision instrument

As protein research progresses, biochemists rely more and more upon instruments of high precision for diffusion and electrophoresis studies. Especially critical are the optical measurements needed to obtain accurate diffusion coefficients, absolute electrophoretic mobilities, and information on purity.

An exceptional optical system is one of the outstanding features which have made the Spingo Model H invaluable for exacting work in both electrophoresis and diffusion. Light passes through each operating cell twice, giving double sensitivity. Patterns are sharply defined and peak positions can be precisely determined. Reproducible measurements may be made to better than 1/25 of a fringe, which corresponds to approximately .00025 percent protein.

The optical system is flexible, too. It permits measurements by five different methods — ordinary and cylindrical lens schlieren, Rayleigh and Gouy fringes, and mechanical scanning.

Further versatility is achieved by a rotary cell turret which supports three operating cells. Any combination of diffusion and electrophoresis studies may be performed simultaneously with the three cells.

We'd like to tell you more about the Model H and how it can fit the requirements of your research program. For complete details, please write Spingo Division, Beckman Instruments, Inc., Stanford Industrial Park, Palo Alto, California, for information File H-5.

Sales and service facilities on the Model H are available on the same basis as for Spingo Ultracentrifuges, assuring prompt, efficient service for users here and abroad.

Beckman®

Spingo Division

Beckman Instruments, Inc.



S-53

B 836717

Biochemicals under
the microscope are
S.O.P.* at NBCo.
We are constantly
striving to explore
today's unknowns to
aid thousands of
investigative and
research chemists all
over the world in
their search for
healthier living for
all mankind.

An inside look at Biochemicals . . .

We offer more than
2,600 Biochemicals
of the finest purity
at the lowest prices.

*Standard Operating
Procedure



SEND FOR OUR FREE MARCH, 1960 CATALOG
FILL OUT COUPON AND MAIL TODAY FOR YOUR COPY.

Name _____ SC

Organization _____

Address _____

City _____ Zone _____ State _____

**NUTRITIONAL
BIOCHEMICALS
CORPORATION**

21010 Miles Avenue,
Cleveland 28, Ohio

Catching Up with a Slippery Equation

What goes on when two moving surfaces are separated by a film of oil?

Simple question? Maybe, but engineers and mathematicians have been trying to answer this classic question of lubrication ever since Osborne Reynolds neatly stated the problem in equation form back in 1886.

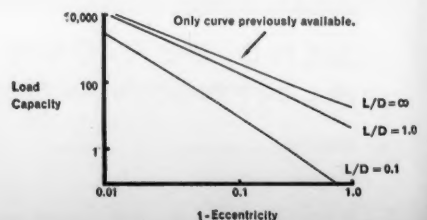
Unfortunately, analytical methods for solving Professor Reynolds' partial differential equation worked only for unrealistic oil bearings, bearings with widths approaching zero or infinity. And approximate methods were crude, requiring a complete recalculation for each slight change in the bearing.

Recently, mathematicians at the General Motors Research Laboratories came up with the most versatile and efficient method of solution yet made. Their analytical method for solving the two-dimensional Reynolds' equation applies to all finite journal bearings — as well as other hydrodynamic bearings — with *no* assumptions or approximations about boundary locations. The new method uses a long-neglected energy theorem recorded by Sir Horace Lamb instead of the force relationship tried by Reynolds and others.

Besides being a valuable contribution to the theory of lubrication, this work has its practical side: namely, accurate, serviceable design curves for engineers. At GM Research, we believe delving into both the theoretical and applied sides of a problem is important to progress. It is a way of research that helps General Motors fulfill its pledge of "more and better things for more people."

General Motors Research Laboratories
Warren, Michigan

Hydrodynamic analyses have led to specific answers about bearing operation. Shown here are the oil pressure distribution (main illustration) and load-carrying capacity for a non-rotating journal with a reciprocating load.



Editorial	Teaching "Science Learnings"	1405
------------------	------------------------------------	------

Articles	Government Organization of Science: <i>D. Wolfe</i>	1407
-----------------	---	------

	Mathematical Evaluation of the Scientific Serial: <i>L. M. Raisig</i>	1417
	Improved bibliographic method offers new objectivity in selecting and abstracting the research journal.	

	Kaj Ulrik Linderstrøm-Lang, Scientist, Man, Artist: <i>H. M. Kalckar</i>	1420
--	--	------

Science in the News	Student Loyalty Oaths; Test Ban Research; Civil Service Raises Pay for Scientists and Engineers	1425
----------------------------	--	------

Book Reviews	R. Firth's <i>Social Change in Tikopia</i> , reviewed by <i>W. H. Goodenough</i> ; other reviews ...	1434
---------------------	--	------

Reports	Form of the Pubic Bone in Neanderthal Man: <i>T. D. Stewart</i>	1437
----------------	---	------

	Fusion of Complex Flicker II: <i>J. Levinson</i>	1438
--	--	------

	Is Reserpine Tranquilization Linked to Change in Brain Serotonin or Brain Norepinephrine?: <i>F. Sulser</i> and <i>B. B. Brodie</i>	1440
--	--	------

	Disulfide Interchange by Ionizing Radiation: <i>D. Cavallini et al.</i>	1441
--	---	------

	Rh ₀ (D) Genotype and Red Cell Rh ₀ (D) Antigen Content: <i>S. P. Masouredis</i>	1442
--	--	------

	Stimulation of Frontal Cortex and Delayed Alternation Performance in the Monkey: <i>L. Weiskrantz</i> , <i>L. Mihailović</i> , <i>C. G. Gross</i>	1443
--	--	------

	Glacial Retreat in the North Bay Area, Ontario: <i>J. Terasmae</i> and <i>O. L. Hughes</i>	1444
--	--	------

	Experimental Production of Mongoloid Hamsters: <i>H. W. Toolan</i>	1446
--	--	------

	Rapid Induction of Allergic Encephalomyelitis in Rats without the Use of Mycobacteria: <i>J. Bell</i> and <i>P. Y. Paterson</i>	1448
--	--	------

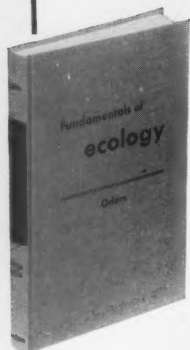
	Induced Phenotypic Resistance to an Antimetabolite: <i>H. S. Moyed</i>	1449
--	--	------

Departments	Letters from <i>N. Pastore</i> , <i>F. C. Leonard</i> ; <i>N. E. Manos</i> ; <i>M. S. Mallén</i> and <i>M. Epp</i>	1400
--------------------	--	------

	Science in Nigeria; Forthcoming Events; New Products	1450
--	--	------

Cover	A late Cretaceous ammonite, <i>Placenticeras pseudoplacenta</i> Hyatt, originally described from Utah. Height, about 11 inches. The photograph was taken with a Polaroid-Land camera (type 53, 4 × 5 professional pan Land film). [Gerry Sharpe]	
--------------	--	--

Check these valuable Saunders textbooks for next Fall's college classes



ODUM—FUNDAMENTALS OF ECOLOGY

Second Edition—A popular college text, this book gives the student a clear picture of the interrelationships operating among plants, animals, microorganisms and his fellow man. It explains what nature "does" as well as how she "looks." Presenting a well balanced synthesis of the entire field of ecology, the textbook combines the *functional* and the *descriptive*, the *aquatic* and *terrestrial*, as well as the *basic* and *applied aspects* of the subject. Outstanding chapter coverage includes: the scope of ecology—

energy in ecological systems—organization at the species population, interspecies population and community levels—freshwater ecology—marine ecology—terrestrial ecology—application of ecology to natural resources, to public health and welfare and to human society—radiation ecology.

By EUGENE P. ODUM, Alumni Foundation Professor of Zoology, University of Georgia, Athens; in Collaboration with HOWARD T. ODUM, Director, Institute of Marine Science, University of Texas, Port Aransas. 546 pages, with 160 illustrations. \$7.50. *Second Edition.*

VILLEE, WALKER AND SMITH—GENERAL ZOOLOGY

Here is a superbly illustrated presentation of modern zoology. This text gives the college student a skillful blending of broad biological principles with a thorough examination of carefully chosen representative animals. You will find a progressive study of protoplasm, cells and tissues and the physiologic mechanisms all animals have in common—respiration, locomotion, digestion, etc. Each major invertebrate phylum is considered in a separate chapter featuring

discussions of one or more typical species. The vertebrates are introduced with a detailed consideration of the frog as representative. Both the vertebrate and invertebrate sections point out not merely the anatomy of the animals described, but also the habitat, mode of life and role in the biological community.

By CLAUDE VILLEE, Harvard University; WARREN F. WALKER, Jr., Oberlin College; and FREDERICK E. SMITH, University of Michigan. 877 pages, with 444 illustrations. \$7.50.

FISHER & KITZMILLER—LAB EXERCISES IN GENERAL ZOOLOGY

This helpful manual gives students a firm basis for laboratory work in zoology. Designed to closely follow Villee, Walker and Smith's "General Zoology" (above), it can be used effectively with any zoology text. Emphasis is placed on principles and functions, not just the dissection of animals. The comparative approach is stressed throughout. The first section of the manual surveys the animal kingdom and includes all the "classical" animals necessary to a beginning course in zoology. The second part is devoted to the com-

parative anatomy of organ systems both vertebrate and invertebrate. Interesting exercises consider: organic evolution; natural history; symbiosis; survey of the animal phyla; muscular systems; gametogenesis; embryonic development; genetics; parasitology; reproduction; etc.

By HARVEY I. FISHER, Ph.D., Chairman, Department of Zoology, Southern Illinois University, Carbondale; and JAMES B. KITZMILLER, Ph.D., Chairman, Department of Zoology, University of Illinois. 227 pages, illustrated. \$4.00.

NOLLER—CHEMISTRY OF ORGANIC COMPOUNDS

Second Edition—Designed for an intensive basic organic course, this text is ideal for students majoring in chemistry or allied sciences. Current concepts of mechanisms are explained and emphasized. Compounds are discussed in the light of the theory of gross structures. Dr. Noller's correlation of physical and chemical properties is extremely clear. By carefully blending theoretical and practical organic chemistry, he stimulates student interest in the mechanisms of

reactions and maintains this interest throughout the entire text. Excellent coverage includes: *absorption of electromagnetic radiation—anhydro sugars—behavior of small ring compounds—natural gases, petroleum and derived products—esters—waxes, fats and oils—derivations of carbonic acid and thiocarbonic acid—carbohydrates—aromatic amines—etc.*

By CARL R. NOLLER, Ph.D., Professor of Chemistry, Stanford University. 978 pages with 106 illustrations. \$9.00. *Second Edition.*

NOLLER—TEXTBOOK OF ORGANIC CHEMISTRY

Second Edition—A careful abridgement of Dr. Noller's longer volume (above), this text maintains the same excellent balance between theoretical and practical organic chemistry. It is ideally suited to organic chemistry courses of 90-100 hours for both chemistry majors and non-chemistry majors. Dr. Noller emphasizes current explanations of physical properties, in order to give the student a clear picture of the nature

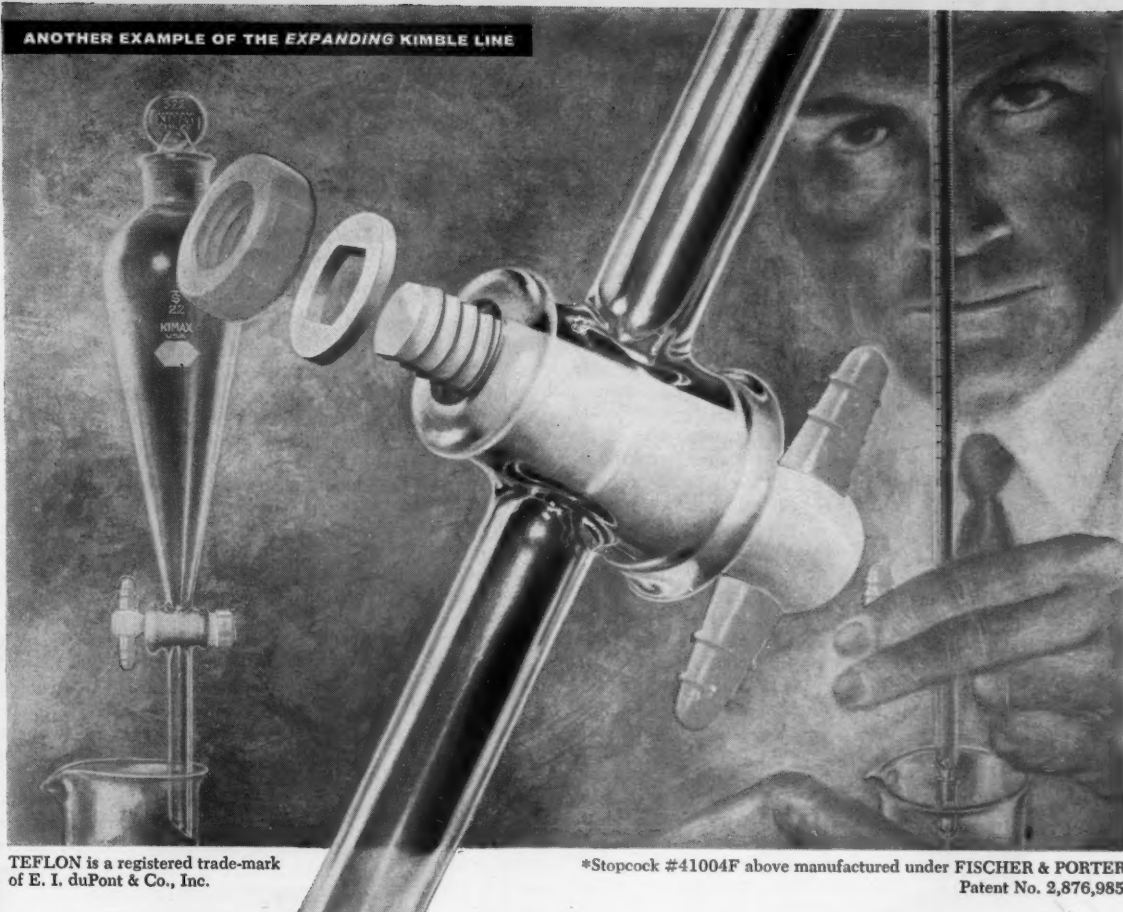
of the forces holding atoms and molecules together. Valuable discussions cover: conformation, inclusion compounds, oxidation mechanisms, insulin, tranquilizer drugs, ferrocene, oxytocin, silicon compounds, tropolones, aldosterone, lanosterol, polyisoprene and urethan rubbers, boron and aluminum compounds, epoxy and polyester resins, etc.

By CARL R. NOLLER, Ph.D. 654 pages, illustrated. \$7.00 *Second Edition.*



Gladly sent to college teachers for consideration as texts
W. B. SAUNDERS COMPANY—West Washington Square, Philadelphia 5

ANOTHER EXAMPLE OF THE EXPANDING KIMBLE LINE



TEFLON is a registered trade-mark of E. I. duPont & Co., Inc.

*Stopcock #41004F above manufactured under FISCHER & PORTER Patent No. 2,876,985.

Simplicity of design makes Kimble Stopcocks with TEFLON® Plugs easy to use, maintain and clean

New Kimble Stopcocks with TEFLON plugs are superior because:

1. Plugs consist of only three parts
2. All three parts are made of self-lubricating, chemically inert TEFLON

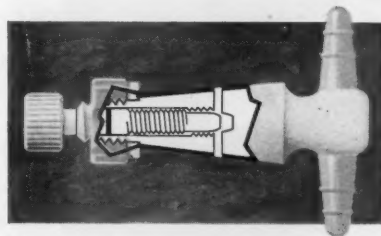
therefore Kimble apparatus and TEFLON plugs . . .

- can be autoclaved
- can be cleaned in acids, alkalis or organics, hot or cold
- will not corrode—there are no metal parts
- can be positively controlled and adjusted—you don't rely on the whim of a spring

- won't bind or leak—accomplished by exaggerated 1:5 taper of plugs in polished glass barrels
- won't freeze because TEFLON is chemically inert

And, threads are exceptionally heavy and coarse to eliminate stripping.

Your dealer has stocks of new Kimble apparatus with TEFLON plugs. They are also listed in the new Kimble Catalog Supplement SP-57. For your free copy, write to Kimble Glass Company, subsidiary of Owens-Illinois, Toledo 1, Ohio.



"New addition"

Now! Kimble adds plugs with metering valve to its TEFLON line. They provide ultra-precise control. Construction is simple for ease of cleaning and use. Available as plug replacement (Catalog #41575F) or in straight bore stopcock #41002F or capillary stopcock #41007F.

KIMBLE LABORATORY GLASSWARE
AN **①** PRODUCT

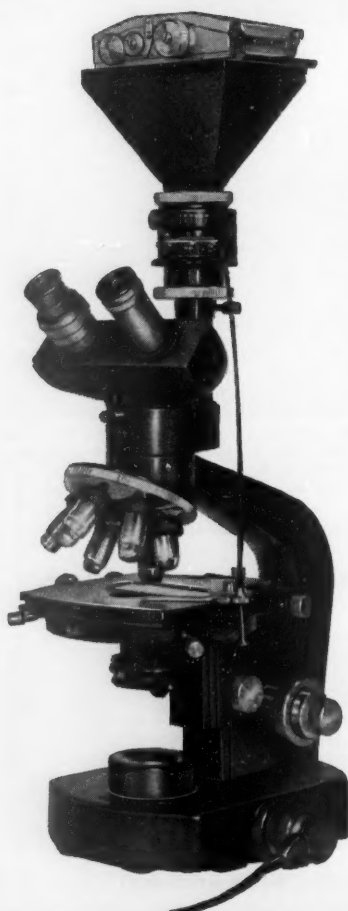
OWENS-ILLINOIS
GENERAL OFFICES • TOLEDO 1, OHIO

WILD* M-20 with Camera II

Fitted with Camera II, this truly versatile microscope permits continuous binocular observation of the specimen, even during exposure. The phototube deflects 25% of the light to the binocular tube, with the remainder going to the Camera. Rapid, accurate focusing is achieved with a special format indicating eyepiece in the binocular tube.

In research and scientific exploration, the M-20 is easily capable of handling any problem which may arise in optical microscopy.

Write for interesting information about the Wild M-20 and its complete range of attachments.



*The FIRST name in Surveying Instruments, Photogrammetric Equipment and Microscopes.

WILD
HEERBRUGG

Full Factory
Services

INSTRUMENTS, INC.

Main at Covert Street • Port Washington, New York
Port Washington 7-4843

In Canada

Wild of Canada Ltd., 157 MacLaren St., Ottawa, Ontario

1400

Letters

Color Phenomena

Recently I reported [*Sci. American* 202, 168 (1960)] that many of the colors described by Land could be obtained binocularly in a procedure that was essentially the same as that of N. Geschwind and J. R. Segal [*Science* 131, 608 (1960)]. Additional unreported results indicate that a "natural image situation" is not necessary for the appearance of colors in a binocular setup. In the attempt to isolate a critical variable and, moreover, to obviate the need for transparencies, I drew two circles in India ink on a white card. The centers were so spaced that when stereoscopic fusion occurred the subject saw two concentric circles. When a red filter (Wratten 25 A) is placed before one eye, the circle stimulating the other eye (no filter) is dark red, and the other circle is green. Changes in the intensity of light can change the green to blue. This result appears to be a case of simultaneous contrast and, of course, is related to colored shadows. The fact that G. L. Walls [*Psychol. Bull.* 57, 29 (1960)] has reinterpreted Land's major results in terms of simultaneous contrast suggests a principle for explaining the colors obtained by me and by Geschwind and Segal.

For an additional point of possible interest I repeated J. L. Brown's procedure [*Science* 131, 155 (1960)] stereoscopically. Brown used a mechanical chopping device for alternately interrupting the two light beams projecting registered images on a screen. Without any filters, Brown reported the usual variety of colors and hues. When I tried this procedure I did not obtain any colors at all.

NICHOLAS PASTORE

Department of Psychology,
Queens College, Flushing, New York

The Term "Cosmoparticle"

A meteorite has been defined as "a solid body of subplanetary mass that either is in space or has come therefrom, is falling or has fallen as a discrete unit onto the Earth or onto some other astronomical body, and still retains its essential cosmic character." Since there seems to be some need now for a term to include all particles of submeteoritic mass, it is proposed that the word *cosmoparticle* be used for this purpose. A cosmoparticle may be defined as "a discrete material entity of submeteoritic mass, either in space or having come therefrom."

Cosmoparticles may be "free" or individual molecules or atoms or molecular or atomic constituents of any kind—ions, atomic nuclei, protons, neutrons, electrons, positrons, and so on. Cosmoparticles and meteorites, as here defined, evidently together comprise all material entities below the category of planet.

FREDERICK C. LEONARD

Department of Astronomy,
University of California, Los Angeles

Stochastic Models

The article on stochastic models of population dynamics by Jerzy Neyman and Elizabeth L. Scott [*Science* 130, 303 (1959)] contains the statement, "with a little luck in attracting the attention of more workers in the field, the process of clustering, with its further theoretical developments, may easily become the basis of a new theory which we like to call indeterministic cosmology." An offer from these particular statisticians to devote their energies to cosmology should not go without comment at a time when more and more observational data will be coming out of this nation's space science program for use in analysis and testing of various models.

The claim by Neyman and Scott that an indeterministic model will solve some problems in cosmology that the deterministic model is incapable of solving goes counter to the feeling of many in the physical sciences who reject any research not aimed at complete understanding, which, to them, means a deterministic model. Any model that is not deterministic is not considered realistic. An explanation in stochastic terms is no explanation at all. Knowledge must be gained with a deterministic model at every step of the way. An unfortunate result of this attitude is that difficulties in a limited area of a given field of research can slow down progress in the entire field until the difficulties are completely resolved in a deterministic manner. This is like not allowing the use of x to represent an unknown quantity, denying the use of algebra, and insisting that all problems must be solved through the more realistic arithmetic methods. Also unfortunate is the fact that frequently there is no meeting of minds in arguments on this point because these implicit assumptions or subconscious convictions do not come to the surface and the controversy centers around secondary concepts that follow from them.

Now let us look at the other side of the problem. Does a stochastic model

IEC



**INTERNATIONAL
MODEL PR-2
REFRIGERATED
CENTRIFUGE**

... first choice for
blood fractionations and
similar low temperature
separations.

**HERE'S WHY MOST LABORATORY
DIRECTORS SPECIFY THE INTERNATIONAL PR-2
FOR LOW-TEMPERATURE SEPARATION**

... It offers positive temperature control with wide-range versatility for separations between -20° and $+10^{\circ}\text{C}$.

The temperature you set on the control panel is automatically held within $\pm 1^{\circ}\text{C}$. In fact, material temperature can be maintained at 0°C indefinitely even at speeds up to 19,000 rpm ... without subcooling rotor or chamber!

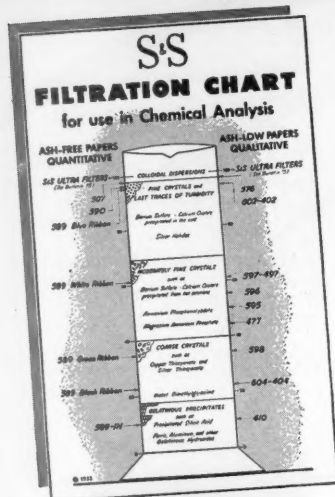
28 INTERCHANGEABLE HEADS ... horizontal, angle, high-speed, high-capacity and shaker ... provide accessory combinations to meet virtually all laboratory needs.

WIDE CAPACITY RANGE ... from 4 liters down to 7 ml. ... is unmatched in the refrigerated centrifuge class.

Write for Bulletin T.

INTERNATIONAL  EQUIPMENT CO.

1219 SOLDIERS FIELD ROAD, BOSTON 35, MASSACHUSETTS



FREE

TO ANALYTICAL CHEMISTS

If you are an analytical chemist, this handy, desk-size S&S Filtration Chart belongs in your laboratory.

Analytical laboratories have long been familiar with standardized, high-quality S&S Analytical Filter Papers.

Now, here is complete data on the relative retention values of S&S Analytical Filter Papers, and other brands, in convenient size for ready reference. This data makes it possible to tell at a glance which grade of paper to select for a given analysis.

Send for your valuable, free S&S Filtration Chart. Act now! Use the handy coupon below!

S&S MEMBRANE FILTERS

S&S Ultraflex Membrane filters for filtration of liquids and gasses have extremely uniform micropore structure. Pore sizes of different filter types range from 5 millimicrons to about 10 microns.

Mail coupon for FREE Chart and Membrane Filter Bulletin

CARL SCHLEICHER & SCHUELL CO.
Keene, New Hampshire, Dept. S-5

Send me your FREE

☐ S&S Filtration Chart

☐ S&S Membrane Filter Bulletin

Name _____

Company _____

Address _____

City _____ State _____

really solve some problems or is it merely a utilitarian way around them? Neyman and Scott seem to take either view at various times. In some of their writings they admit that their stochastic approach may be at least partly utilitarian. In other places they state that the people who espouse determinism are trying to explain an indeterministic world with a deterministic model and so are doomed to failure. This can alienate some potential friends from the physical sciences. In yet another place Neyman calls such speculation idle. It may be idle technically but it can affect cooperation among scientists from different disciplines. A more accurate way of saying the same thing might be that the utilitarian aspects in the work of Neyman and Scott stand up no matter how we view the basic nature of the universe. The random portion of a stochastic model can be used to describe: (i) a truly random process; (ii) a process that appears random to us; (iii) a process that is too complex to be described completely.

If the world is basically indeterministic, the stochastic model can, of course, be realistic. If the world is basically deterministic, the stochastic model can still be thought of as a utilitarian generalization of a deterministic model. For example, when research reaches an impasse such as the contradiction between the cosmological principle and local irregularities, one can bypass it by the use of a stochastic model. The former impasse becomes an "island of indeterminism" within an otherwise deterministic model. Such a model can never explain in deterministic terms that part of the mechanism which has been assumed to be random. This statement is trivial but it does point up an important divergence in "parlance" between some theoretical statisticians and some physical scientists. To a statistician, any reduction of unexplained variation can be called an explanation. He can happily refer to an explanation of the behavior of aggregates in an "island of indeterminism" while the physical scientist bemoans the fact that the behavior of individuals is unexplainable with such a model.

Perhaps such divergence in views can be reconciled. To a statistician, any particular model is highly expendable. As knowledge increases, one can construct newer models with a decreasing area of indeterminism so that one approaches a deterministic model. The ultimate degree of approach will depend upon the nature of ultimate reality. A scientist can believe whatever he wishes about the ultimate state of affairs and still accept the stochastic model for its utilitarian aspects. This should be comforting to those in the physical sciences who like to feel that they are now

working with reality even though the model they are using has replaced many former models and will itself inevitably be replaced some day.

NICHOLAS E. MANOS
National Aeronautics and Space
Administration, Washington, D.C.

Detecting Antibodies to Penicillin

The report by Marguerite Epp [*Science* **130**, 1472 (1959)] that sera from penicillin-allergic subjects agglutinate erythrocytes coupled to penicillin by means of a bis-diazotized-benzidine linkage confirms results of my co-workers and me with the same method plus the use of human antiglobulin (Coomb's) reagent as a final step to "develop" the reaction. As a matter of fact we believe that our procedure, as reported to the first Latin American Congress of Microbiology (Mexico, 12-19 October 1958) and to the National Congress of Allergists (Toluca City, Mexico, May 1958), avoids the necessity of making the "checkerboard" titration that Epp uses.

References to our work appear only in Spanish [reports and abstracts of works presented to the first Latin American Congress of Microbiology (1958); F. Martínez and L. Martín *Prensa méd. Mex.* **24**, 245 (1959); M. Salazar Mallén and L. Ortiz, *Alergia Rev. iberoam. alergol.* **7**, 348 (1959); and the thesis of L. Ortiz, University of Mexico (1959)].

We believe that the description that Epp gives of the method she uses and the information given here will encourage other investigators to take advantage of this first specific in vitro procedure, so useful in our hands, for diagnosing or confirming diagnoses of penicillin allergy.

M. SALAZAR MALLÉN
Medellín 94, Mexico City, Mexico

There are several points of importance in M. Salazar Mallén's letter which, I think, should be made clear. I rather question his statement that the "checkerboard" titration to establish the optimal ratio of penicillin to bis-diazotized-benzidine is unnecessary. In practice, there are variations in biological and chemical products. For example, the optimal ratio may vary as follows: from 2.5 to 4.5 mgm of penicillin to from 0.25 to 0.5 ml of the diluted chemical compound. Moreover, the method of Salazar Mallén and his collaborators and that described by me differ in principle. The former detects incomplete antibodies, whereas the procedure described in my report measures complete antibodies.

MARGUERITE EPP
Department of Bacteriology, University
of Saskatchewan, Saskatoon



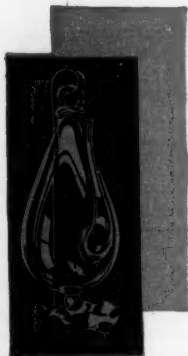
Don't Shortchange The Student!

The school and college laboratory is the training ground for budding scientists. It is in school that they learn the fundamentals which they carry throughout their entire lives. It is in school that they formulate the thought processes which they put to good use in the years following graduation.

Because of the importance of this training, no school or college will offer students an inferior textbook or an incompetent instructor. The best is none too good for the scientist of tomorrow!

Similarly . . . the best in laboratory equipment is none too good for today's scientific student. Unfortunately, there is available in this field, laboratory glassware which is known as the "second", or "school" grade of well-known manufacturers.

Don't cheat your students of the opportunity to work with the best available laboratory glassware . . . especially when you can buy it cheaper than some of the "inferior" grades. Specify Diamond D and be sure of the best. For the complete story of Diamond D manufacture write today for our booklet "Behind The Diamond D" Doerr Glass Company, Vineland, N.J.



OL' NANTUCKET WEATHER GLASS

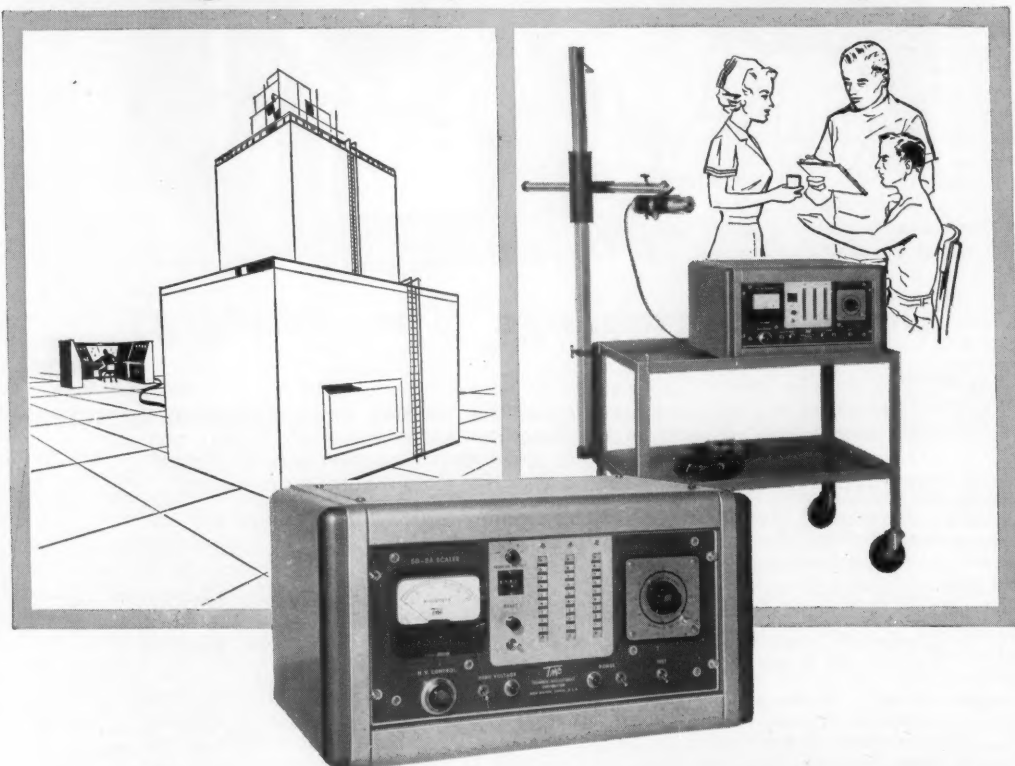
Here is a hand-blown replica of the weather glasses used on the square-rigged sailing ships that rounded Nantucket Light more than a century ago. It is a crystal-clear pear-shaped pendant which hangs on a 10 1/4" long wrought iron bracket. Fill the glass with water according to directions; chart shows how to translate movement of water in spout in terms of weather forecasts. Ideal for home, office, den, recreation room, college dorm or classroom. \$3.95 postpaid. Doerr Glass Specialties, Inc., Vineland, N.J. Offer good only in continental U.S. and Canada.

Diamond D Laboratory Glassware

Quality Begins With Price And Ends With Performance



FOR RELIABLE SCALING— in making radioisotopes...or monitoring them



PERFORMANCE DATA

The SG-2A Scaler is a completely self-contained unit consisting of:

AMPLIFIER — Chase Higinbotham non-blocking type with selectable sensitivity — 1, 10 or 100 millivolts neg.

Rise time — 0.20 μ s.

Dynamic range (at 1 mv. sens.) 10,000 to 1.

POWER SUPPLY

Dual Ranges 300 to 1000 volts, 300 to 2500 volts.

Stability — 2 volts low range, 4 volts high range (under normal operating conditions.)

(Available on special order with 5000 volt power supply for counters using high voltage gases. Dual ranges 1000 to 2500, 1000 to 5000 volts.)

SCALER — three etched wire decade strips followed by a precision four digit counter. Counts — to 240,000 CPM with less than 1% coincidence loss.

Resolving time — 2.5 μ s.

Auto-time — pre-set or elapsed time from 1 sec. to 60 min.

Accuracy \approx 0.2 sec.

(Model SG-2A4 also available with all electronic pre-set count from 100 — 10,000 counts.)

TMC MODEL SG-2A SCALER PROVIDES ACCURACY YOU CAN DEPEND ON—AT THE REACTOR, LABORATORY OR HOSPITAL

When the SG-2A is used as part of *reactor instrumentation*, the one millivolt sensitivity and wide dynamic range of its Chase Higinbotham non-blocking amplifier permit accurate measurement of neutron levels at start-up long before the less sensitive operating instruments detect their presence. For *medical diagnostic procedures* using radioisotopes, many hospitals find that the SG-2A with the mobile cart and detector arm (above), provides the reliability and good reproducibility that are particularly necessary for thyroid function studies and blood and plasma volume measurements using Iodine (I^{131}) tracers, or in determining red cell mass with radiochromium (Cr^{51}). Countless other applications of the SG-2A range from radioactivity protective monitoring systems in industry to experimental work in college laboratories — wherever there is need for accurate radiation measurement.

If you use radioisotope tracers, write for complete information on the SG-2A Scaler, or related TMC detectors, pulse height analyzers, ratemeters and other instruments. By describing your work and the radioisotopes being used, you will enable TMC to recommend the most suitable instruments for your needs.



TECHNICAL MEASUREMENT CORPORATION
441 WASHINGTON AVE., NORTH HAVEN, CONN.

AMERICAN ASSOCIATION
FOR THE
ADVANCEMENT OF SCIENCE

Board of Directors

CHAUNCEY D. LEAKE, *President*
THOMAS PARK, *President Elect*
PAUL E. KLOPSTEG, *Retiring President*
HARRISON BROWN
H. BENTLEY GLASS
MARGARET MEAD
DON K. PRICE
MINA REES
ALFRED S. ROMER
WILLIAM W. RUBEY
ALAN T. WATERMAN
PAUL A. SCHERER, *Treasurer*
DAEL WOLFE, *Executive Officer*

Editorial Board

DONALD J. HUGHES H. BURR STEINBACH
KONRAD B. KRAUSKOPF WILLIAM L. STRAUS, JR.
EDWIN M. LERNER EDWARD L. TATUM

Editorial Staff

DAEL WOLFE, *Executive Officer*
GRAHAM DUŠANE, *Editor*
JOSEPH TURNER, *Assistant Editor*
ROBERT V. ORMES, *Assistant Editor*

CHARLOTTE F. CHAMBERS, SARAH S. DEES, NANCY
S. HAMILTON, OLIVER W. HEATWOLE, YUKIE
KOZAI, HOWARD MARGOLIS, ELLEN E. MURPHY,
ELEANOR D. O'HARA, BETHSABE PEDERSEN, NANCY
L. TEIMOURIAN, DAVID A. TEMELES, LOIS W.
WOODWORTH

EARL J. SCHERAGO, *Advertising Representative*



SCIENCE, which is now combined with THE SCIENTIFIC MONTHLY, is published each Friday by the American Association for the Advancement of Science at National Publishing Company, Washington, D.C. The joint journal is published in the SCIENCE format. SCIENCE is indexed in the *Reader's Guide to Periodical Literature*.

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts and illustrations, see *Science* 125, 16 (4 Jan. 1957).

Display-advertising correspondence should be addressed to SCIENCE, Room 740, 11 West 42 St., New York 36, N.Y.

Change of address notification should be sent to 1515 Massachusetts Ave., NW, Washington 5, D.C., 4 weeks in advance. If possible, furnish an address label from a recent issue. Give both old and new addresses, including zone numbers, if any.

Annual subscriptions: \$8.50; foreign postage, \$1.50; Canadian postage, 75¢. Single copies, 35¢. Cable address: Advancesci, Washington.

Copyright 1960 by the American Association for the Advancement of Science.

Teaching "Science Learnings"

A chapter on elementary-school "science learnings," as the author likes to call it, in a recent volume of essays by professors of education contains much with which we agree. The volume is *Modern Methods in Elementary Education* (Henry Holt and Company), edited by Merle M. Ohlsen of the University of Illinois, and the chapter is by J. Myron Atkin, of the same university. It is entirely sensible, as the chapter suggests, to teach the simpler aspects of a subject before broaching the more complex aspects. And we concur that a good science program must have materials for experimentation. But we cannot give the chapter our full endorsement. Atkin, in his enthusiasm to establish that pupils should be taught things that have meaning for them, uses a few expressions whose connotation may lead beginning teachers into unrecommended patterns of pedagogy.

One place where the reader may be led astray is in the discussion of breadth versus depth in "science experiences." The need is cited for youngsters to "have experiences with electricity in the first grade, again in [the] second, more in [the] third." The notion of a continuing program of study is good, but we must caution the reader that by "experiences with electricity" Atkin means only what in more prosaic language we would call "studying electricity"—using well-insulated magnets, buzzers, and the like. He is not suggesting that teachers should administer shocks to their pupils. Admittedly, however, such procedure would make sense in a historical approach to teaching science, for it was just by giving himself shocks and comparing their strength that Cavendish in the 18th century was able to anticipate some of the discoveries of Ohm and Faraday.

The account offered of a hypothetical classroom also requires interpretation. An enlightened teacher is described as listening to his pupils' reports on their recent efforts at testing hypotheses. The children "told of hypotheses they had formulated and tested. Some hypotheses they had tested by simple experimentation. Some they had tested by going to books or adults." Here the beginning teacher should not be awed by the achievements of his pupils as they "test hypotheses." Simple experimentation is simple experimentation, and in going to books and adults the children most likely are doing what we more ordinarily would call "looking things up" and "asking questions." We do grant, however, that by these activities the boys and girls really *could* be testing hypotheses: the hypotheses, for example, that they can read and that grown-ups do not know everything.

A final word of caution concerns the general argument of the chapter; this, as stated by the editor in an introductory note, is that even young children should be taught "to apply the scientific method in solving their everyday academic and personal problems." A timely example of scientific method applied to personal problems, although on a national level, is a theory recently worked out by Senator Muskie of Maine. According to the theory, in the coming presidential election, either Humphrey or Kennedy could beat Nixon, but Rockefeller could beat both Humphrey and Kennedy. The Senator notes that the candidate with the longest name has the best chance of winning: Hoover beat Smith; Roosevelt beat Hoover, Landon, Willkie, and Dewey; Truman beat Dewey; and Eisenhower beat Stevenson. Our final word to beginning teachers, and to the youngsters too, is, do not bet on the election.—J.T.

Fully Automatic, Transistorized **AUTO-GAMMA[®]** Spectrometer System

for counting samples of:

IODINE¹³¹

IRON⁵⁹

GOLD¹⁹⁸

RADIUM
DAUGHTERS

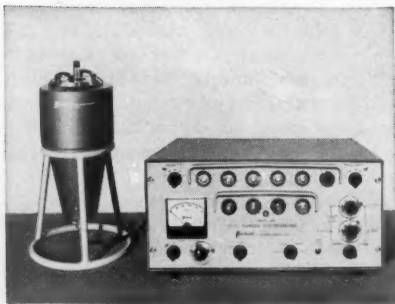
POTASSIUM⁴²

CHROMIUM⁵¹

COBALT⁶⁰

... and other gamma emitters—

- up to 100 samples counted automatically
- repeats individual samples or entire loading
- symmetrical geometry provides constant background
- sample number, time and count printed out on paper tape
- integral, differential and wide-window counting modes
- manual model can be automated at any time



For complete information write for Bulletin 400.



The Auto-Gamma Spectrometer System counts and records data from as many as 100 test tube samples. Operation can be maintained on an around-the-clock basis.

The energy spectrum of an isotope can be plotted with the Auto-Gamma Spectrometer by means of the precise Narrow Window setting. Ordinarily, the photopeak is then counted within the Wide Window of the pulse height analyzer to minimize background. This use of the spectrometer optimizes the count-to-background ratio and permits shorter counting periods or lower tracer levels.

Obviously, automatic sample counting is desirable when large numbers of samples are to be counted. It is just as useful, however, for counting small numbers of low activity samples. Blanks and standards can be arranged among the samples for background checks and calibration. The complete series of tubes can then be counted automatically as many times as required to give desired statistical accuracy.

The detector and spectrometer components of the system are available separately for manual operation.

Packard

Instrument Company, Inc.

P. O. BOX 428-A, LA GRANGE, ILLINOIS

ATLANTA • BOSTON • LOS ANGELES • NEW YORK • PHILADELPHIA
PITTSBURGH • SAN FRANCISCO • WASHINGTON, D. C. • ZURICH, SWITZ.

Government Organization of Science

Dael Wolfe

This article is based upon a seminar discussion held 8 and 9 January 1960, in which the participants were Lloyd V. Berkner, president of Associated Universities, Inc.; A. Hunter Dupree, associate professor of history, University of California (Berkeley); James McCormack, vice president, Massachusetts Institute of Technology; James M. Mitchell, director, Conference Program on Public Affairs, The Brookings Institution; Emanuel R. Piore, director of research, International Business Machines Corporation; Don K. Price, dean of the Graduate School of Public Administration, Harvard University; and the author.

This group came together to discuss the recommendations that a Department of Science and Technology be established in the federal government. It was agreed in advance not to try to decide whether or not the group favored a Department of Science and Technology, but to concentrate on the reasons for considering such a department, the alternative forms it might take, and their probable consequences for science and engineering and for the ability of the federal government to carry out its responsibilities in these fields.

At the conclusion of the discussion, the participants decided not to prepare a group report but asked me to take

individual responsibility for that task. The result is based directly on the group discussion and has profited from the criticisms that members of the group gave to a first draft, but it does not represent their unanimous opinion. In fact, some of them disagree with some of the statements that I have chosen to retain despite their disagreement. The participants are, however, unanimous in hoping that the article will be helpful to scientists and others who are concerned with problems of science administration and the effectiveness with which the federal government carries out its scientific and technical responsibilities.

A Department of Science and Technology in the federal government, a department headed by a cabinet secretary and responsible for a considerable range of scientific and technological activities, has been proposed in several recent Senate bills and recommended by several science administrators. The idea is an old one. Dupree has traced it back to the Constitutional Convention (1). Always before, for one reason or another, the opposition has been stronger than the support, and that may be true again, for while a strong case can be made for some major changes, there are good arguments against the specific proposals that have been made. Opinion differs all the way

from the assertion that a Department of Science and Technology will certainly be established within the next five years to the equally flat assertion that such a change is impossible. Whatever decisions may in time be made, the topic merits careful analysis, for involved are issues dealing with the delineation of the responsibilities of the federal government, its effectiveness in carrying them out, and the extent to which science and engineering can make their proper contribution to national objectives. It therefore seems desirable to analyze the objectives to be sought and to consider the probable consequences of various organizational arrangements.

In the years since World War II, changes in government organization have been many and sweeping. Increasing awareness of the role of science and engineering in national affairs and their increasing contribution to national security and welfare have led to the establishment of the Atomic Energy Commission, the National Science Foundation, the National Aeronautics and Space Administration, and the Department of Health, Education, and Welfare; to several major reorganizations of military research and development; to creation of the post of Special Assistant to the President for Science and Technology and the Federal Council for Science and Technology; and to a greatly enhanced status of the President's Science Advisory Committee. These are not all of the changes since World War II in federal administration of scientific and technical activities, but only those that have attracted widest attention (2).

Despite these changes, there still remain some major organizational and administrative problems, and there continue to be suggestions for further change, of which the most prominent is the proposal that there be established a Department of Science and Technology. Such a department has been recommended in several recent Congressional bills (3) and in analyses by Berkner (4) and Brode (5) of deficien-

The author is executive officer of the American Association for the Advancement of Science.

cies in the present administrative arrangements. Arrayed in opposition to a Department of Science and Technology have been the judgment of the President's Science Advisory Committee (6), the Science Policy Committee of the Republican National Committee (7), the majority sentiment of the participants in the AAAS Parliament of Science held in 1958 (8), the Administration, and a substantial number of witnesses before Congressional committees.

It is not our purpose to give a simple yes or no answer to the question, Should there be a Department of Science and Technology?, but rather to examine some of the reasons for proposing such a department, and to analyze the questions that must be answered before one decides what changes are desirable.

There is a terminological difficulty in discussions of a Department of Science and Technology, because scientists and engineers distinguish *science* from *engineering*, while headline writers tend to cover the whole gamut of research, development, and engineering with the one word *science*. Because government jargon follows headline writers' usage, the title "Department of Science" does not differ in meaning from the more frequently used title "Department of Science and Technology"; under either title the department would include both science and engineering. Engineers have recommended that the word *engineering* be used in place of *technology*, but the suggestion has not been generally adopted. The title "Department of Science and Technology" is therefore used here. In discussing subject matter, *science* is used to mean pure, or basic, or fundamental science, while such terms as *science and engineering*, or *research and development* are used when the broader range of activities is meant.

In starting out to discuss a Department of Science and Technology, one really should define the term. But there is no precise definition. Different users of the title may have quite different organizations in mind. In general, they refer to a branch of government at the same organizational level as the Department of Commerce or the Department of Health, Education, and Welfare, and, like them, headed by a secretary who sits as a regular member of the President's cabinet. But ideas concerning the scope of the proposed

department and the scientific and engineering activities that should be transferred to it vary widely among the advocates, and even more widely among the opponents, of such a department.

Organizational Objectives

An administrative structure can be judged in terms of the effectiveness with which it achieves its objectives. The arguments advanced in favor of a Department of Science and Technology constitute claims that certain objectives could be better attained with that form of organization than they can be under the present organization. These arguments require analysis, for one reason because they are not always explicitly stated in the advocacy of such a department, and for the more important reason that the worthier of them constitute a useful set of criteria for appraising the merit and probable consequences of the several kinds of Department of Science and Technology that have been proposed and of other administrative changes that may be considered.

1) *Operational effectiveness.* A major criterion for judging an organization is its ability to get the assigned jobs done as well as possible. The jobs for which the federal government is partly responsible include basic research in all fields of science, applied research on a wide variety of practical problems, and the development of new services, instruments, weapons, power sources, remedies, agricultural products, and a host of other devices, methods, and useful end products. To accomplish these purposes, work is carried out in government laboratories and institutions, in organizations wholly supported by government funds but privately managed, and in industrial, university, and other private or public agencies that are partly supported by government funds. The purpose is partly to provide scientific and technical information or services to the nation as a whole (for example, weather forecasting), partly to support responsibilities that are peculiarly those of the government itself (such as the maintenance of national defense), and partly to strengthen research and education in science throughout the nation. It is essential that these widely varying responsibilities be kept in mind, for whatever form the organization takes, it must be able to deal effectively with every field of

science and every form of application of scientific and technical knowledge.

2) *Efficient organization.* Both Congress and the President must deal with all of the scientific and engineering agencies. Thus, the number of different agencies, their interrelations, and their coordination influence not only the operating effectiveness of the agencies themselves but also the effectiveness with which Congress and the President can carry out their responsibilities of reviewing, directing, and supporting those agencies.

Eleven years ago, the Hoover Commission on Organization of the Executive Branch of the Government reported that "the executive branch is not organized into a workable number of major departments and agencies which the President can effectively direct, but is cut up into a large number of agencies which divide responsibility and which are too great in number for effective direction from the top" (9).

Proponents expect that the merger of a number of agencies into a single department would reduce duplication of effort and would bring about a better coordinated total program. These changes would probably result, but the changes would not be unmixed blessings. Some kinds of duplication are to be avoided, while others are sometimes to be sought. In basic research, rapid and effective interchange of information is a better means of preventing unwanted duplication than is centralized control, for at this level scientists do not knowingly duplicate the work of others, except when duplication is required for verification. In production and procurement, and in the construction of highly specialized facilities, duplication is ordinarily to be avoided. But in applied research and early prototype development, deliberate duplication of effort is frequently desirable. Competition toward a single end is a well-recognized practice in industry, and it has been useful in some government-sponsored activities. Witness a variety of examples, including alternative means of producing fissionable material under the Manhattan Project, alternative designs of power reactors, and the competition between solid and liquid propellants. Creation of a departmental organization may reduce some unnecessary duplication; to eliminate duplication entirely should never be the objective.

As for centralization and coordination, although the merger would probably accomplish only a small reduc-

tion in the total number of scientific and technical agencies, it could bring under one head several agencies that account for a substantial portion of the nonmilitary research and development budget and that occupy a considerable fraction of the time Congress devotes to scientific and technical matters. On the other hand, independent agencies have their own budgets for review by the Bureau of the Budget and by Congress. They have their own hearings before Congressional committees, and each has some congressmen who maintain a close interest in its affairs. Merging such agencies into a single department would bring about greater centralization of planning and responsibility, but both Congress and the President would lose some of the present closeness of contact with each. It is significant that Congress established the National Aeronautics and Space Administration and the Atomic Energy Commission as separate agencies rather than as parts of existing departments.

3) *Higher status.* Proponents sometimes argue that the establishment of a Department of Science and Technology would enhance the status of research and development as a government activity and would lead to larger appropriations than are possible when the same activities are widely scattered through a number of departments and agencies.

The status argument is probably sound. Public prestige attaches to a cabinet position, and a Secretary of Science and Technology would serve as a symbol of the national importance of research and development. But the status argument is not compelling. The Atomic Energy Commission and the National Aeronautics and Space Administration are probably as well known and get as much public attention as do many of the federal departments.

The argument that financial support would be increased is of doubtful validity. The argument runs that many of the scientific and engineering activities of the government are now buried fairly deeply in departments that have much wider responsibilities and that therefore do not support their research and development activities as vigorously as would a Department of Science and Technology. The argument may carry weight, but Congressional appropriations reflect interest in the purposes being supported and a sense of their national importance. One must at least ask whether the large appropriations

for nuclear physics have not come because of wide popular interest in the purposes which atomic energy is expected to serve, and whether the increasing appropriations for biological sciences have not come about because of skillful marshaling of public interest in the diseases for which the National Institutes of Health have undertaken to seek cures.

4) *Sound policy development.* Scientific and technical activities constitute essential support to the operations of many federal agencies, and constitute one of the elements that must be considered in numerous aspects of broad national policy. At some point in the federal structure there should be a mechanism for bringing all the scientific and technological threads together, both from the standpoint of establishing policy for research and development agencies and from the standpoint of the contributions these agencies make to national policy.

Three general classes of policy problems are involved. One is to provide broadly for the advancement of science and its practical applications. To avoid misunderstanding, it should be pointed out that policy guidance should not mean centralized direction of the work of individual scientists. The weight of much experience warns against any such effort. But research is not wholly a matter of individual decision; it depends increasingly upon the funds and facilities that are available. As equipment and facilities become more costly (consider high-energy accelerators, radio telescopes, oceanographic vessels, and so on), it becomes more clearly a matter of general policy to decide which new facilities can be afforded, which are likely to make the greatest contributions to science and which to the attainment of other national objectives.

The second class includes the contributions that scientific and technical knowledge can make to the solution of other national problems. A widely discussed current example is the ability to detect nuclear explosions, and the influence this ability has on decisions concerning disarmament and inspection.

The third class includes the influence of national needs on science and technology. Political, military, and economic needs help to determine the emphasis to be given to different technological areas and even to different fields of research.

Whoever has responsibility for making decisions on these interrelated issues

must have opportunity and authority to review the entire research and development effort of the nation and to give due consideration to other policy issues.

5) *Major improvements.* Sometimes vague in its expression, but important in its sense of urgency, is the final argument that a drastic improvement in the ability of the federal government to cope with scientific and technical problems is essential, and that a Department of Science and Technology would achieve improvement simply by being a large, prestigious, and centralized agency with major responsibility for a wide sweep of scientific and engineering problems and developments. Sometimes the feeling is expressed with frank admission that the speaker does not know what organizational details would prove most effective, but that "something ought to be done" to enable the federal government to exercise more constructive leadership in the nation's total research and development effort. Embodied here are ideas of prestige, support, policy guidance, effective coordination, ability to anticipate future requirements, and ability and imagination to focus major attention on the problems and areas that will add most effectively to national strength, welfare, and prestige.

In a sense, this argument is a summary or a synthesis of the preceding ones, but it is also more than that, for an organization might carry out its duly assigned responsibilities effectively, meet the canons of good organization, enjoy substantial prestige, and provide for proper policy coordination, yet still be so rigid and unimaginative as to be unable to anticipate and prepare for new requirements and opportunities or to cut down or close out activities of diminishing returns. Government responsibilities change, and so do scientific and engineering capabilities. If an administrative organization is too rigidly bound to currently recognized opportunities and requirements, it cannot change readily to meet new conditions. Somewhere in the organization there must be high competence to recognize and meet new requirements and opportunities. This, in the minds of many critics, is the primary objective to be sought in any plan of reorganization. They would be quite willing to support an organization that fell short on some of the preceding points if it gave hope of achieving radical improvement in this respect.

The public interest. The executive

and legislative branches of government serve and represent the general public. It is thus also necessary that the administrative arrangement contribute as fully as possible to public understanding of the scientific activities of the government. Federal expenditures for research, development, and engineering mount year after year and now account for a tenth of the federal budget (though less than 1 percent of the budget is used for basic research). The general public has both an interest in and a need to know what is going on. An additional criterion of administrative arrangements is therefore the effectiveness with which the organizational structure meets this need and the extent to which it fosters public recognition of the place and role of science and engineering in government affairs. But the criterion of public interest is only indirectly involved in selecting one or another administrative pattern, for in the long run the public interest will be best served by adopting the administrative arrangements that most adequately satisfy the other criteria. Under any form of organization there will remain a continuing obligation to keep the public informed of problems, progress, policy, and possibilities, but the form of organization that can best serve the public interest is the one that can most effectively carry out its assigned responsibilities, provide the basis for enlightened policy, help Congress and the President fulfill their responsibilities, and foresee and prepare for the future.

Organizational Alternatives

With the objectives in mind, it is possible to examine alternative organizational possibilities. It should be recognized, however, that the form of organization that best meets one criterion may not best meet another. Thus, weighting the arguments differently may lead to different judgments concerning alternative possibilities. It should also be recognized that a purely logical organization, one created *de novo*, is impossible. Compromise among different points of view and concession to past history and existing realities are inevitable.

One over-all department. Discussion of the possibility of combining all research and development activities of the government into a single Department of Science and Technology is largely a matter of belaboring a straw

man, for no serious proposal of such an all-encompassing department has been advanced. Yet the idea must be examined, for it represents one popular concept of a Department of Science and Technology and is the concept against which the most vigorous opposition has been expressed.

Merging all scientific and technical agencies of the government into a single department would, in one dramatic step, provide for the more effective meeting of most of the criteria discussed above. Public interest in and appraisal of the role of science and engineering in government would be enhanced, for they would be placed on a par with agriculture, defense, commerce, and the concerns of other cabinet departments. There would be one cabinet officer to whom Congress could turn for information and whom the President could hold responsible for all research and development activities; over-all policy-making responsibility could obviously be his, as could responsibility for meeting new scientific responsibilities. On these grounds, one all-inclusive department looks good, but the gains would be achieved at the expense of a drastic reduction in the ability of some departments, such as Defense and Agriculture, and their research and development branches, to carry out their continuing, day-by-day responsibilities, and this loss would be so great that the idea of an all-inclusive department must be rejected.

The primary role of government-sponsored research and development is to help in carrying out other responsibilities. It is true that the federal government has adopted the wise, long-range policy of supporting and strengthening pure science and science education. But in general, scientific and technical offices and laboratories are established and supported primarily for the services they can render their respective agencies. It follows that the organization of research and development should be planned to give maximum support to the related operational responsibilities. Two principles emerge.

1) Scientific and engineering activities that are intimately related to the operating responsibilities of an agency belong in the agency. Research on military problems cannot be divorced from the Department of Defense without weakening our defense capability. Research on agricultural problems is an integral part of the activities of the Department of Agriculture. Wherever

this relationship holds, wherever the operating responsibilities of an agency are firmly rooted in an active program of research and development, the research and development activity should remain as an integral part of the agency concerned.

2) Science and technological development have so much in common and benefit so much from each other that in any particular area, such as nuclear energy, the two should remain under the same administrative direction. One implication of this principle is that if existing agencies are brought together into a new department, that department must deal with both science and technology, not with pure science alone. Another implication is that applied science and the closely related pure science work of existing agencies should not be separated. Either both should be transferred or both should be left where they are. The President's Executive Order 10521 recognized this principle in stating that medical, agricultural, defense, and other agencies that have large responsibilities in applied science are expected to support and carry out fundamental research on topics closely related to their operating responsibilities.

These principles seriously challenge any plans for a Department of Science and Technology that would include all scientific and technical activities of the government and any plans that would separate research from closely related technological development or application.

Senate bills. In recent years, several bills proposing the establishment of a Department of Science and Technology have been introduced in Congress. The major current one is S. 676, introduced by Senator Humphrey and others. It proposes to combine into a single department the National Science Foundation, the Atomic Energy Commission, the National Aeronautics and Space Administration, the National Bureau of Standards, and several functions of the Smithsonian Institution. In the main, these are agencies of wide interest to Congress and the public; several might be called "glamor" agencies. The Atomic Energy Commission and the National Aeronautics and Space Administration deal with the newest and most spectacular fields of science and technology. The National Science Foundation is the one general-purpose scientific agency of the government. The National Bureau of Standards deals

directly with business and industry.

The merger of these agencies into a single department would centralize responsibility for a number of important activities in the hands of one cabinet officer who could report directly to the President and the Congress. The numerical decrease in the number of scientific and engineering agencies would be relatively small, but the ones brought together would be major ones, to which both Congress and the President must give substantial amounts of attention. There would, therefore, be some advantages in efficiency of organization, prestige, and policy-making responsibility.

There would also be disadvantages. From the standpoint of the agencies themselves, it is widely feared that some of them would lose their effectiveness under the proposed merger. The National Science Foundation and the selected portions of the Smithsonian Institution are devoted to basic research and to education in science. These responsibilities would constitute only a minor fraction of the total program of the department, and it is feared that they would suffer as a consequence. The Atomic Energy Commission has a budget several times larger than any of the others, and most of its funds are used for production rather than for research and development. The principal officers of the new department would of necessity have to give greatest attention to atomic energy activities, including the production of atomic devices. As a general principle, it seems unwise to combine agencies of diverse interest when one is so much larger than the others. In particular, it seems unwise to subjugate a number of agencies in which the major emphasis is on research and development to a much larger one in which the major emphasis is on production. There is good reason to fear that the result would be an enlarged Atomic Energy Commission responsible for a number of not very closely related other activities, that the agencies concerned would not be helped by the merger, and that the total ability to meet new needs and opportunities would not be sufficiently increased to justify adopting this proposal.

A department of environmental sciences. Berkner (4) used a different criterion for selecting the agencies that might be merged into a department: to increase the effectiveness of the agencies themselves. On this basis he would exclude research and development activi-

ties that constitute integral parts of the agencies in which they are now located—for example, the Departments of Agriculture and Defense. He would also exclude those agencies that are primarily responsible for supporting research carried out by others—the National Science Foundation and the Department of Health, Education, and Welfare. Finally, he would exclude the independent agencies that are already large and strong, the Atomic Energy Commission and the National Aeronautics and Space Administration.

When these three groups are excluded, there remains a number of scientific and technical bureaus that Berkner believes could be moved without seriously harming the departments in which they are now located, because they are not integrally bound to those departments. Because these bureaus have much in common, he believes that bringing them together in a single department would strengthen all of them. This department would include the Weather Bureau, the National Bureau of Standards and its Central Radio Propagation Laboratory, the Coast and Geodetic Survey, the Hydrographic Office, the Geological Survey, the Office of Scientific and Technical Information, the Antarctic Office of the Navy Department, the Antarctic program of the National Science Foundation, the Fish and Wildlife Service, and the Naval Observatory.

There is no obvious title for such a department. With the major independent agencies left out, along with the scientific activities that are functioning well in other departments, it would seem inappropriate to use such a general title as "Department of Science and Technology." The title "Department of Environmental Sciences" does not cover all of the proposed activities but does indicate the centralization of emphasis on problems of understanding, using, and controlling man's physical and biological environment.

A significant difference between this proposal and that of the Senate bill is in the organizational status of the agencies that would be combined. The Senate bill would combine whole agencies (except for parts of the Smithsonian Institution); Berkner would withdraw selected activities from the departments in which they are now located and combine them into a new department. It would therefore be necessary in each individual case to examine the activity in detail to determine whether it would

seem to be better located in the present or in the proposed new location. For example, the fact that some 75 percent of the work of the National Bureau of Standards is concerned directly with industry makes its location in the Department of Commerce seem reasonable. But the fact that the Bureau of Standards receives substantially less than half of its funds from the Department of Commerce suggests that the relationship could be severed without seriously disrupting its services to the nation. One would want to avoid severing a really fundamental working relationship, for such a step would probably require the old department to establish an agency similar to the one it had lost by transfer. We would then have two agencies where before there was one.

Some of these agencies have been moved in the past. The Weather Bureau was originally established in the Department of the Army, then transferred to the Department of Agriculture, and later transferred again, to the Department of Commerce. In none of these locations was its relationship to the parent department the intimate and essential one that exists between the Department of Defense and its research and development units. Instead, the Weather Bureau is an aid to the military services, to agriculture, to commerce, and, indeed, to the nation as a whole, and will continue to be so whether it remains in the Department of Commerce or is transferred to a new department.

An advantage of a department constituted as Berkner has proposed is that the research activities for which these several laboratories and agencies are responsible could be carried out more effectively, for they have closely related scientific interests, they could profit from each other, and they could profit from being in a department in which science and technology was the central theme instead of a side issue. Bringing them together into a single department would seem likely to raise the status and improve the scientific work of all of them. The opposing argument, the weight of which would have to be determined in each individual case, is the extent to which service functions would be weakened by the transfer.

Within the wide range of the environmental sciences, a department so constituted could be given responsibility for the development of new scientific activities. When oceanography, meteorology, geophysics, or other new fields are not a major responsibility of any

agency, no agency is likely to push very hard for their development. But a department devoted wholly to scientific and technical activities would be more likely to be on the alert to identify areas that need special emphasis, and more eager to secure the facilities they require, for its reputation would depend entirely upon the effectiveness with which it carried out scientific and engineering responsibilities.

Policy responsibilities would not be changed in principle by merging this list of agencies into a new department, but there would be improvements, for one major, well-coordinated agency would replace a number of smaller and scattered ones. From the standpoint of Congress, the flow of information concerning scientific activities would be better coordinated, even though the total number of departments reporting to Congress would be increased by one. The new department would not, however, include any of the agencies in which Congress is most keenly interested.

There are additional respects in which this proposal differs from those embodied in Senate bills. No one agency is so large as to overwhelm the others. This is an advantage. Another difference is that the list does not include any of the big, glamorous agencies that in the public mind or in the headline writers' vocabulary mean science—Defense, Atomic Energy, or National Aeronautics and Space Administration. To the public, and probably also to many members of Congress, this collection of agencies does not "look like" a cabinet-level department; combining them into a single agency would appear to be a mere rearrangement of administrative structure rather than the creation of a new department to recognize their enhanced role and status.

Cabinet status would seem more reasonable if one or more of the prominent independent agencies were also included. There are three to consider: the Atomic Energy Commission, the National Science Foundation, and the National Aeronautics and Space Administration. The reasons previously given for not merging the Atomic Energy Commission with a diverse group of smaller agencies would also hold here; the AEC should not be included.

It is more difficult to decide about the National Science Foundation. This agency, with minor exceptions, has not itself operated research and develop-

ment programs but has worked through grants made to others. It is devoted primarily to basic science, while the others are concerned with applications. In general, a department that has both operating and grant-making functions tends to give priority to the operating responsibilities, and one that has responsibilities for both pure and applied science tends to give priority to applications. Thus, the NSF would run a double risk if it were to be included. But there are arguments on the other side of the case that should also be considered. The Office of Naval Research, the National Institutes of Health, and some of the private foundations have demonstrated that it is possible to administer a grant program effectively while at the same time conducting excellent research in one's own laboratories. A Department of Environmental Sciences that included the National Science Foundation could follow in this tradition, but the scope of operations of the NSF would have to be broader than the scope of the rest of the department. Whether the NSF should be included or left in its present independent status is still an open question.

The National Aeronautics and Space Administration should be included. While NASA commands a much larger budget than do any of the other agencies, the disadvantage of that disparity is more than offset by the similarity of functions and the closeness of scientific relations that would obtain between NASA and the other agencies. NASA, like the others, deals with man's environment, and there would be mutual benefit in the close affiliation of NASA with the geophysical, meteorological, and other research of the agencies that would be included in a department dealing with the environmental sciences. These relationships are, in fact, likely to become closer in the future than they are at present, as increased ability to carry out space research provides more powerful support to studies of the earth and its atmosphere and the energy exchanges that shape man's physical and biological environment.

The department originally proposed by Berkner would be strengthened by inclusion of the National Aeronautics and Space Administration, and perhaps also by inclusion of the National Science Foundation. This would be a department that would strengthen its constituent parts, that would have sufficient size and range to constitute a strong

element in the general policy formulation realm, and that would be both broad enough and sufficiently well balanced to serve effectively as the agency responsible for keeping the nation abreast of new developments and new opportunities.

More fundamental reorganization. Brode (5) has proposed a Department of Science that differs from the others not in the specific agencies to be incorporated but in its emphasis upon a major regrouping of scientific and technological functions. Brode accepts the general principle that scientific activities essential to the work of an operating agency should be left in that agency, but points out that authority to engage in basic research in fields that underlie an agency's operating responsibilities has sometimes been used as license to support an unnecessarily wide range of scientific activities. "Thus, a Department of Science, while not removing from agencies such as Defense and Agriculture, . . . the research programs specific to their missions, should include all major segments of science not specifically pertinent to those missions."

The result would be a department of very wide scope, with "separate bureaus or institutes . . . to deal with space, atomic energy, medicine, weather, patents, science information, physical science, geology, and other recognized areas of importance." Brode does not spell out the implications for existing agencies; it is a concept he offers rather than a complete set of plans. But presumably the department would incorporate a number of existing agencies, such as the Geological Survey, the Weather Bureau and the National Science Foundation. Presumably also it would incorporate entirely or would take over the "scientific" portion of the responsibilities of the Atomic Energy Commission and the National Aeronautics and Space Administration. And, as pointed out above, it would include some of the scientific activities of other departments—for example, Defense and Agriculture.

This department would have the advantages that are inherent in greater centralization of authority and responsibility. It would provide a more centralized channel for Congressional information and interest. The department would clearly be of such size and scope that it could have major responsibility for new developments and could have

an important role in the making of scientific policy.

On the debit side, there would be the difficulties, pointed out in discussing other proposals, of merging diverse independent agencies and the additional difficulties of separating from a number of other agencies a portion of their basic research activities. Each such separation would require careful analysis to determine how much of what kind of scientific work should be left with the parent agency and how much should be transferred to the new department; making these decisions would undoubtedly involve much friction. The testimony of directors of applied research laboratories supports the arguments that better scientific talent can be recruited if the scientists are offered some opportunity to engage in research of their own choice, and that some engagement in basic research enables a laboratory concerned with applications to understand better the implications of basic research for the applied work it is doing. Clearly there will be difficulties in deciding where to draw the line if the general concept is accepted that research essential to the best interests of the agency responsible for applications is to be left with that agency while other research is transferred to the new department.

A careful study, as Brode has recommended, will be required before this proposal can be fully evaluated, for here again is a case in which the recommendation that a department be established brings in its train a whole series of specific detailed questions.

Other Possibilities

None of the proposals for a Department of Science and Technology is entirely satisfactory, yet each helps to show deficiencies in the present administrative structure. Perhaps too much attention has been devoted to a specific form of organization—a cabinet department—and not enough to the objectives. It may be worth while to take the major objectives as a point of departure and to ask what organizational changes would bring about greatest improvement in ability to attain those objectives, and also to ask how well the present arrangements are likely to meet these objectives.

Meeting new needs. A fundamental issue in the administration of research

is the determination of the basis on which funds and facilities should be allocated among different fields and programs. At one extreme, research workers themselves make the important decisions because the allocation of available funds is made to accord with their research plans and project requests. At the other extreme, the allocation is made by science administrators who select the areas and types of research from which they expect the greatest return of scientific knowledge or practical application. In practice, probably every agency compromises between these two extremes, but there are situations in which a reasonably close approach to one or the other extreme is appropriate. The National Science Foundation is devoted to basic research and has adopted the policy of not attempting to direct the course of science by channeling its funds into one or another field that appears to its officers as most likely to "pay off." Yet the NSF has quietly favored some areas of basic research that its officers thought needed special stimulation. Thus it has given special support to oceanography and astronomy, and more recently to meteorology, and it secured and administered the funds for U.S. participation in the International Geophysical Year.

In contrast, the applied-science agencies have typically channeled their grants into those fields of research and development that have appeared most likely to support their responsibilities. Yet many of these agencies have also supported basic research, sometimes over a wider range than their operating responsibilities made necessary.

For a large range of basic and applied research, these two methods of allocating funds effectively complement each other. They leave a gap, however, an important gap that includes those areas of research that appear to be ripe for intensive development but that are not likely to be energetically exploited by an applied-science agency because no appropriate agency exists. Even without special help, such fields will normally grow, but perhaps too slowly for the national interest. This is by no means a new problem. The National Advisory Committee on Aeronautics was established to give special support to aeronautics. More recently, the National Aeronautics and Space Administration was established to give special support to space science

and exploration. The speed with which science is gaining new knowledge and the speed with which new knowledge can frequently be turned to practical use suggest the desirability of giving greater emphasis to the effort to identify other fields of research which appear ready to respond to special emphasis and support by advancing to the state on which major practical applications could be based. In this middle ground, between pure basic research, for which outcomes cannot be clearly foreseen, and research in support of applications that have already demonstrated their worth, some very hard choices would be necessary. Difficult as the choices would be—and everyone involved would have to be reconciled to the prospect of some costly mistakes—the position of the United States as a scientific leader may well depend upon our willingness to gamble that the benefits of such an effort will exceed its cost. The gamble is a good one, for despite their difficulty, choices can be made, and the penalty for not making them will be a series of expensive crash programs entered into in an effort to make up the ground we failed to cover earlier in a more orderly fashion.

No agency now has responsibility for the area of new developments, but under the special circumstances of World War II, the Office of Scientific Research and Development and the Manhattan Project had this spirit. We need now an office with the same spirit, and with the same wide-ranging authority to undertake work in whatever areas appear sufficiently promising to justify special support. This agency would of necessity work flexibly and in cooperation with other research and development agencies and would normally transfer to other appropriate agencies responsibility for continuing those programs that had demonstrated their worth.

Responsibility for new developments might be handled in any of several ways. One would be to create a special agency just for this purpose. Another would be to divide responsibility among existing agencies, giving to each a kind of free-wheeling authority to select, explore, and develop relevant new areas. (An example is the Advanced Research Projects Agency of the Department of Defense.) Still another would be to assign responsibility to an existing agency. Among those now in existence, only the National Science Foundation is

broad enough in scope, but to assume this responsibility the NSF would require additional funds and authority from Congress and a major policy decision that it should go beyond the area of basic research that has been its primary responsibility.

Of the Departments of Science and Technology that have been suggested, some could and some could not reasonably be given responsibility for new developments. An all-encompassing department could. The department proposed by Berkner could cover a considerable range of possibilities, and the one proposed by Brode an even broader range. A narrowly confined department would have neither the appropriate authority nor the staff.

Whether or not a Department of Science and Technology is established, an urgent problem is that of achieving greater competency for looking ahead to identify and develop those areas of research that are not yet the responsibility of one of the applied-science agencies but that appear likely to produce major advances and applications in return for special support and research opportunity.

Over-all scientific policy. The percentage of the nation's total scientific effort that is financed by the federal government has become so great that the government cannot escape major policy responsibility. It establishes policy anyway, whether it wills to do so or not. Under these circumstances, conscious, deliberate arrangements for policy responsibility are essential.

Individual agencies, such as the National Science Foundation, and inter-agency consultative bodies, such as the Federal Council for Science and Technology, can have important roles in the policy sphere, but they cannot be all-sufficient. Neither a single agency nor a consultative body nor a cabinet department can evaluate competing demands among agencies at its own organizational level. Furthermore, the final choices on major matters cannot be separated from decisions concerning the national budget, military security, economic welfare, and other national issues. It follows that the center of policy responsibility must lie close to the President. Nowhere else can general policy responsibility for research and development be placed so effectively, just as nowhere else can responsibility for budget review be adequately handled (10).

If the Office of the President is to have the competence to exercise the policy role wisely, the staff must include men who are highly skilled in the management of scientific affairs and who can relate scientific matters to all of the other considerations that are involved in major policy decisions. The President has a Special Assistant for Science and Technology and a Science Advisory Committee that can make suggestions, criticize policies, serve as a forum and board of review, advise the Bureau of the Budget and operating agencies, and, in general, serve as a powerful aid to the President in the making of major policy decisions.

Even though the same man has thus far served both as Special Assistant to the President for Science and Technology and as chairman of the Science Advisory Committee, the distinction between the two positions should be kept clear. The Science Advisory Committee and its chairman may very properly place first emphasis in their thinking on the scientific and technological needs of the nation and the national implications of scientific and technological developments. Thus the Science Advisory Committee should be free to criticize established or proposed policy if damage to the nation's research and development program is foreseen. In contrast, the Special Assistant to the President is part of the Presidency and must always subjugate specifically scientific or engineering considerations to the totality of all factors involved in making policy decisions. The chairman of the President's Science Advisory Committee should be able to go to the President and say, "Mr. President, this is what we as specialists in science and engineering think should be done. . .," while the Special Assistant for Science and Technology must help the President to decide what must be done in light of all of the considerations involved. Whether the chairman and the Special Assistant are the same man or different men, the President needs the best scientific and engineering advice available, and then needs an Assistant for Science and Technology who can help him to weigh, judge, incorporate, and perhaps override that advice in establishing national policy. The present arrangements for these functions seem to be working effectively.

Congressional responsibility. Congress needs better means than it now has for making decisions concerning sci-

entific and technical matters. Required are better channels of information and better provisions for reaching well-informed decisions. The present system is one of multiple channels of information and multiple committees to deal with the information. Traditionally, the two Houses of Congress have had essentially parallel committee structures, in which each committee deals with agriculture, defense, commerce, or some other area, and in which each committee is responsible for those matters of research and development that constitute part of its area of general responsibility.

Merging some of the scientific and engineering agencies into a single agency would consolidate some of the channels of information, but multiple channels would remain, and would continue to be desirable. In addition, Congress needs to have a good over-all view of these matters. With the establishment of the National Science Foundation, Congress acquired a source of general report concerning basic research activities, and the chairman of the Federal Council for Science and Technology has now been authorized to report to Congress on scientific and engineering matters generally. There are sound reasons for exempting the President's personal assistants from the requirement of reporting directly to Congress, but special considerations in the case of science and technology suggest the desirability of perfecting arrangements to provide Congress with the systematic, general reviews concerning research and development problems and progress that are available to the executive branch through the Federal Council and through the Science Advisory Committee.

Congressional committee structure has also been changing. When the Atomic Energy Commission was created, Congress established a Joint Committee on Atomic Energy to serve both the Senate and the House of Representatives. More recently the Senate established the Committee on Aeronautical and Space Sciences, and the House of Representatives, the Committee on Science and Astronautics. The latter has an unusually broad charter that has permitted it to study a wide variety of scientific and engineering matters.

Congress might follow any of three lines in an effort to develop a committee structure still better equipped

to cope with the wide range of scientific and technical problems. One would be to extend the scope of the House Committee on Science and Astronautics and the Senate Committee on Aeronautical and Space Sciences so that both would become general committees on science and technology. Any such extension of authority must, however, be limited, for it is altogether unlikely that the committees now responsible for agriculture, health, or defense matters—to take these as major examples—would wish to relinquish responsibility for the scientific and engineering aspects of their areas of responsibility.

The second possibility would be to establish a committee comparable to the Joint Committee on the Economic Report. This committee serves both Houses of Congress but is not directly responsible for legislation in either. It holds hearings, analyzes the annual report of the President on economic matters, keeps under review other evidence concerning the economic health of the nation, and serves as an adviser to committees that have direct legislative responsibility. A similar advisory committee on all scientific and engineering matters could be established.

The third possibility would be to establish a joint committee for science and engineering similar in function to the Joint Committee on Atomic Energy. While the Joint Committee on Atomic Energy has worked successfully within its area of responsibility, its chairman and executive director have warned that the total range of scientific and technical problems is too wide to be handled by a single committee (17). Nevertheless, a committee with responsibility for legislation has some advantages over a committee that can only review and advise.

How to choose among these alternatives is clearly a matter for Congress to decide, but the arrangements decided upon should be such as to encourage interested members of Congress to specialize on scientific and engineering matters and to make their legislative careers in large part dependent upon their knowledge and special interest in this field, just as other congressmen now establish their legislative reputations as specialists on foreign relations, national defense, or fiscal policy. One of the losses that results from the present highly fragmented system is that the system does not sufficiently encourage

the development of a group of congressmen interested in, well informed about, and continually reviewing the scientific and technological problems of the nation.

Continuity versus Change

One of the organizational possibilities to consider is continuation of present arrangements. General policy responsibility is being effectively exercised by the Special Assistant and the Science Advisory Committee. The flow of information to Congress is being improved and could be improved still further. Responsibility for new developments is lacking and should be provided for under any organizational pattern. That leaves for special consideration the question of coordination and effective action by the existing research and development agencies. The key to improvement in this respect lies in the hands of the Federal Council for Science and Technology. The Council was created by the President because it seemed to him and the Science Advisory Committee to be more desirable than the creation of a new department.

When the President's Science Advisory Committee proposed the establishment of the Federal Council, they recommended that it include the heads of major independent research and development agencies and the Assistant Secretaries, or comparable policy-level officers, who were responsible for all research and development activities in the departments they represented. When the President issued the executive order establishing the Federal Council, the wording was changed; policy-level officers of departments are included, but they need not have responsibility for all research and development in their departments. Some departments—Agriculture and Defense—already had top-level officers responsible for research and development; they serve on the Federal Council. Other departments—Commerce and Interior—did not have such officers, have not appointed them, and are represented by members who do not have over-all responsibility for research and development in their departments. Thus the Federal Council is not as well informed a body nor one whose members all exercise as direct research and development responsibility as the Presi-

dent's Committee had in mind in recommending its establishment.

The original idea of having within each department an Assistant Secretary (or comparable officer) responsible for all research and development activities, and of using these officers as a strong coordinating council, is still worthy of consideration. This arrangement could solve some of the problems of interagency cooperation, could bring about greater support for important agencies that have not had top-level representation, and could provide the President and Congress with information concerning the total research and development program. Whether or not the Federal Council as now constituted will work out satisfactorily remains to be seen; its trial period has been too brief for us to be certain. But greater effectiveness could be expected if all of its members were of the kind originally intended.

The value of change. Senility affects organizations as well as men. Agencies that once were full of vigor and promise have been known to lose their best men to competitors, to promote the remaining ones to positions of seniority, and gradually to lose all youthful vigor. The problem of maintaining organizational virility is perhaps more difficult in government service than elsewhere because of the government's competitive disadvantage in securing and retaining the ablest men. It is partly to overcome this difficulty that a number of major research and development activities have been established as contract laboratories, wholly financed by federal funds but administered by a university or industry.

An organizational change may sometimes be justified not because the new pattern is inherently better than the old one but because the change provides an opportunity to bring in new blood and to accomplish the reinvigoration that in an ideal world would not be necessary. This may not be the most respectable argument in favor of a new pattern of organization, but it is nevertheless a practical argument that should be considered along with the reasons for and against a particular change and the anticipated difficulties of bringing a new organization into being. The argument also implies its corollary, that a new organizational pattern is likely to wear out, and to have to be replaced by a still newer one sometime in the future.

The Question of Status

Much of the discussion of a proposed Department of Science and Technology has involved arguments over the desirability of having a secretary in the cabinet. From the standpoint of working effectiveness, meeting new needs, and effective relationships with Congress and the President it should be pointed out that merging a number of existing research and development activities into a single agency not of cabinet status would probably be about as effective as combining the same activities into a department of cabinet rank. The chief officers of the National Science Foundation, the Atomic Energy Commission, and the National Aeronautics and Space Administration are, on appropriate occasions, invited to attend cabinet meetings. They have access to the President, can administer their own agencies, and can discuss their problems with Congress as readily as can cabinet officers. So could the head of a new independent agency. Cabinet status has symbolic value, but the cabinet is no longer as powerful a body as it once was, and cabinet rank is not an essential of better organization.

In the eyes of many scientists and engineers, cabinet status would have a real disadvantage. The cabinet is not only an arm of government but also—despite the occasional appointment of someone from the other party—an arm of the President's political party. A Secretary of Science and Technology might be well trained in science or engineering and have appropriate administrative experience in these fields—in fact there is good reason to expect that he would—but the necessary qualifications would also include interest and ability to work in the cabinet as a political arm of the President's party. The head of a noncabinet agency would also be expected to have technical and administrative qualifications, and of course he would have to be able to work effectively with the President, but he would not have to be involved in party politics.

A related status question is sometimes overlooked. There is a necessarily inverse relationship between an administrator's closeness to the center of high-policy responsibility and the single-mindedness with which he can concentrate on any particular element that goes into total policy. Top-policy control

cannot be divided. Budgetary, scientific, political, defense, economic, social, and other factors must be closely intermeshed. Whoever might be appointed to head a new agency—whether of cabinet status or not—would be working at a level at which scientific and engineering matters must be geared into the mechanisms of economic, budgetary, security, and personnel management of national affairs. In order to be effective at this level, one must be much more than an able and vigorous spokesman with a wide understanding of scientific and technical matters. One must also accept the fact that these matters constitute only part of the basis for decision making.

A Study Commission

There is no answer in any of the above to the question, Should there be a Department of Science and Technology? The question is not yet ready for an answer. When considered in the abstract, without specifying what the new department would include and without examining in detail the difficulties that would be created, the idea of a Department of Science and Technology looks attractive. It is in line with the general trend toward greater centralization of responsibility. It would make sense to the general public as a constructive, forward step that would bring about better coordination, reduce unnecessary duplication, and provide higher-level responsibility for the nation's critically necessary scientific and technological progress. It would give Congress a more direct basis for coming to grips with the major problems of science and technology and would lead to the growth of informed and responsible committees in Congress. These changes in Congress would require the executive branch to organize better its presentation of scientific and technological problems.

All of this is to the good, but each specific proposal for a Department of Science and Technology has serious weaknesses and seems to create or augment about as many difficulties as it was intended to solve. Criticism of the specific proposals does not mean, however, that there is no problem, but only that the right solution has not yet been found.

A new department—or a new agency not at cabinet level—is not the only

possibility. Much of the reason for advocating a cabinet department could be achieved by other changes: (i) top-level representation and support for research and development in those departments in which these matters are not now satisfactory, and insistence upon full cooperation in and through the Federal Council for Science and Technology; (ii) making more available to the Congress the information and advice of the President's Science Advisory Committee; (iii) improvements in the Congressional committee structure; and (iv) the establishment of a special agency to meet new scientific and engineering needs and opportunities or the assignment of this responsibility to an existing agency.

Which of the possible alternatives would be the best means of achieving all of the desirable improvements remains an open question. The responsible Senate committee recognizes the complexity of the problem and now recommends the adoption of a bill (S. 1851) to establish a commission on a Department of Science and Technology. The commission would consist of 16 persons, eight appointed by the President and four each by the President of the Senate and the Speaker of the House of Representatives. Four members would be from the executive branch of the government, men participating in federal scientific activities; eight would be prominent scientists from outside the government; and four would be members of Congress. Half would be from one political party and half from the other. The commission would be asked to determine "(1) the desirability of establishing within the executive branch of the Government a Department of Science and Technology in order to provide more effective and better centralized and coordinated science programs and operations within the Federal Government, and (2) if the establishment of such department is desirable, which functions now exercised by other departments or agencies of the Government should be transferred to such department and what, if any, new functions should be given to such department."

There are two difficulties with this means of seeking a solution to the problem. The first is that the question to be asked of the commission is not broad enough. At this stage we should not be restricted to the question, Is a department desirable?, but should try to an-

swer the question, What is the best solution? The other difficulty is in the composition of the proposed commission. As a bipartisan commission, half of the members would represent a political party that has already recorded its opposition to a Department of Science and Technology. This fact almost guarantees a balancing membership of persons committed to support the idea. At this stage the idea needs nonpartisan analysis rather than bipartisan compromise.

Whether the commission is appointed or not, means of improving the administrative arrangements with which the federal government carries out its scientific and technical responsibilities will continue to be discussed. The decisions that will ultimately be made will be

sounder ones if scientists and government representatives have considered the alternatives objectively and have analyzed the probable consequences of various organizational patterns.

References and Notes

1. A. H. Dupree, *Science in the Federal Government* (Belknap Press of Harvard Univ. Press, Cambridge, Mass., 1957).
2. J. A. Killian, Jr. [*Science* 129, 129 (1959)] and L. V. Berkner [*ibid.* 129, 817 (1959)] discuss recent changes in administrative procedures.
3. The bills in question are: S. 676, 86th Congress, first session, by Senator Hubert Humphrey and others; S. 586, 86th Congress, first session, by Senator Estes Kefauver; several similar earlier bills that died in committee; and S. 1851, 86th Congress, first session, by Senator Hubert Humphrey and others. The latter bill differs from the others in recommending a commission to study a Department of Science and Technology, rather than recommending specific plans for such a department.
4. L. V. Berkner, *Science* 129, 817 (1959).
5. W. R. Brode, *ibid.* 131, 9 (1960).
6. The President's Science Advisory Committee, *Strengthening American Science* (Government Printing Office, Washington, D.C., 1958).
7. Republican Committee on Program and Progress, *The Impact of Science and Technology* (4 Oct. 1959).
8. *Science* 127, 852 (1958).
9. Commission on Organization of the Executive Branch of the Government, *First Finding* (Government Printing Office, Washington, D.C., 1949).
10. D. K. Price [*Science* 129, 759 (1959)] gives an excellent discussion of organizational and policy problems and of the impossibility of assigning policy responsibility to the head of a Department of Science and Technology or the head of any other operating agency. E. R. Piore and R. N. Kreidler [*Ann. Am. Acad. Pol. Soc. Sci.* 327, 10 (1960)] and W. D. Carey [*ibid.* 327, 76 (1960)] present illuminating discussions of the roles of the President's Science Advisory Committee, the Special Assistant for Science and Technology, and the Bureau of the Budget in carrying out Presidential policy responsibilities.
11. C. P. Anderson and J. T. Ramey, *Ann. Am. Acad. Pol. Soc. Sci.* 327, 85 (1960).

Mathematical Evaluation of the Scientific Serial

Improved bibliographic method offers new objectivity
in selecting and abstracting the research journal.

L. Miles Raisig

In the 33 years since the report in *Science* of the Gross and Gross (1) method of weighing the value of the serial publication in the field of chemistry, scientists, librarians, and literature specialists have sought to provide similar "objective" evaluations for serials in several other fields.

Those later studies, which lay claim to objectivity through the counting of the number of citations quoted, rest quite solidly upon the assumptions made by Gross and Gross in 1927. (i) The value of any journal in any

scientific field may be measured directly and objectively by determination of the number of times the journal is cited in the literature of that field; that is, the greater the number of citations, the greater the value of the journal. (ii) Any well-used, subjectively valuable journal in the scientific field may be chosen as the source for counting citations to other journals.

In those studies it is further variously assumed that the journal selected as a source of citations is representative of the field, and that if two or more source journals are used, both or all may be weighted equally.

In a recent thorough review of the basic citation method, I found it to be

neither scientifically objective nor mathematically sound, based as it is upon raw counts of citations wholly unrelated to the numbers of original articles published.

Qualitative Measurement Possible

In this article is offered an improved citation-count method, designed to measure qualitatively the value of any scientific serial by means of a related quantitative citation count.

Unlike the method of Gross and Gross, this improved method does not (i) underrate the serial which must for a temporary period suspend publication or reduce sharply the number of original articles it customarily publishes (for example, many German journals during 1917 and 1918); (ii) overrate the serial which, by reason of a few heavily cited articles, appears to be of considerable value; or (iii) overrate the serial which publishes a large number of very short articles (for example, *Comptes rendus de l'Académie des sciences*), which therefore may appear to be relatively heavily cited.

In theory the new method rests upon the following assumptions. (i) Any original (hitherto unpublished) article which appears in a serial publication has immediate and retrospective "reader impact"; that is, it may immediately or in the future be used and quoted in the preparation of another original article

The author, former chief of the Technical Services Division of the U.S. Military Academy Library, West Point, N.Y., is now a research assistant, School of Nursing, Yale University, New Haven, Conn.

and therefore has research potential. (ii) The research potential of any one original article may be expressed as unity (1.0). (iii) The research potential of all of the original articles in any one unit or volume of a serial publication may be expressed as the total number of articles times 1.0. (iv) The research potential indicated by the total number of original articles in one unit of one serial publication may be contrasted mathematically with the totals for original articles in comparable units of other serials.

Steps in Evaluation

In practice the method requires the following steps. (i) One unit or volume of one or more journals is chosen as the source(s), and all citations appearing there are tabulated separately by journal and period of time. (ii) These tabulations are corrected to include counts of single references to original articles only. (iii) The number of original articles appearing in each cited journal within each period (to the year of count) is tabulated. (iv) The relationship of the number of articles quoted to the number of articles published [the "index of research potential realized" (RPR index)] is found for each journal for each period by dividing the citation count by the published-article count for that period. The decimal part of 1.0 resulting is the "RPR

index," and that journal which has the highest index is considered the most valuable.

In order to demonstrate the operation and possible value of this method, the five journals that ranked highest for the period 1871-1925 in the Gross and Gross study were re-counted and re-evaluated: *Berichte der deutschen chemischen Gesellschaft*; *Journal of the Chemical Society* (London); *Liebigs Annalen der Chemie*; *Zeitschrift für physikalische Chemie* (Leipzig); and *Comptes rendus de l'académie des sciences*. The citations to these journals in the *Journal of the American Chemical Society* (2) were carefully screened and tabulated. All references which did not specifically relate to these journals were deleted; as in the Gross and Gross study, all references to the *Journal of the American Chemical Society* were excluded. Each remaining reference was traced to the article cited and was counted only if the article was original. A citation to any article was counted once only, regardless of the number of times the article itself may have been quoted. Excluded from the counts of original articles were letters, review articles, reports of patents, book reviews, abstracts, and purely biographical material. Since *Comptes rendus de l'académie des sciences* included articles on a number of subjects, only those relating to chemistry were counted. In Table 1 appear the Gross and Gross raw counts of citations and the

corrected citation counts and total original article counts made in the study under discussion. In Table 2 appear the RPR indexes and the ranks in both studies, for the periods 1871-1925 and 1916-1925, respectively, for the five journals that were re-evaluated.

Changes in Journal Ranks

It may be noted that while there are minor differences in the RPR indexes for the period 1871-1925 for the *Journal of the Chemical Society*, *Annalen der Chemie*, and *Zeitschrift für physikalische Chemie* (and these differences are not critical), the *Berichte der deutschen chemischen Gesellschaft* drops in rank from first in the Gross and Gross study to fourth in this study. The *Journal of the Chemical Society*, *Annalen der Chemie*, and *Zeitschrift für physikalische Chemie* each advance one step in rank. Coincidentally, *Comptes rendus de l'académie des sciences* keeps the same rank in both studies, but it is likely that in any re-evaluation of a large number of journals by the present method it would drop to a much lower rank.

With the widespread use of the basic Gross and Gross method, there has arisen a marked difference of opinion concerning its value in the objective evaluation and selection of scientific periodicals. Brodman (3) in 1944 and Postell (4) in 1946 both found con-

Table 1. Results of citation and article counts for the period 1871-1925, made in this study and in the Gross and Gross study. (a) Gross and Gross raw count of citations; (b) single-citation corrected count made in this study; (c) original article count made in this study.

Study	1871-1875	1876-1880	1881-1885	1886-1890	1891-1895	1896-1900	1901-1905	1906-1910	1911-1915	1916-1920	1921-1925	Totals
<i>Berichte der deutschen chemischen Gesellschaft</i>												
a	33	44	53	56	60	64	79	115	67	30	78	679
b	32	43	47	58	55	64	76	116	62	32	84	669
c	1895	2628	2886	3447	3106	2886	3597	3413	2239	1243	2182	29,502
<i>Journal of the Chemical Society</i>												
a		1	2	5	20	21	47	45	60	37	122	360
b	4	5	6	9	19	16	40	40	52	30	103	324
c	204	340	347	392	488	590	790	1126	1226	624	1855	7,982
<i>Liebigs Annalen der Chemie</i>												
a		13	18	19	21	22	23	33	37	8	26	220
b	9	13	17	17	21	19	18	32	34	9	23	212
c	717	578	492	594	599	470	439	548	506	159	372	5,474
<i>Zeitschrift für physikalische Chemie*</i>												
a				6	16	28	19	29	21	6	53	178
b				6	15	27	22	24	20	3	46	163
c				289	524	623	645	779	672	188	648	4,368
<i>Comptes rendus de l'académie des sciences</i>												
a		8	9	7	21	15	23	15	23	3	26	150
b	3	2	2	8	9	9	22	16	24	1	26	122
c†	980	1159	1224	1320	1467	1605	1858	1687	1469	642	1516	14,927

* Began publication in 1887. † Articles on chemistry only.

siderable reason to question the value of the citation-count method. Brodman sought but failed to find a close correlation between the ranks of physiology journals established by raw counts of citations and the ranks revealed through an opinion poll of medical-college personnel. Postell, in relating Brodman's ranks to ranks based on the circulation statistics of the library of a college of medicine, found some correlation between the ranks from the opinion poll and those from the library statistics, but little correlation between the latter and ranks from raw counts of citations. Stevens (5) in 1953 found the raw count method useful in the main. Morgan (6) in 1957 applied the raw count method to a study of periodical literature in the field of physiology and found evidence of the method's usefulness. It is obvious that when such a difference of opinion exists there is ample reason for endeavoring to develop a method that is more mathematically sound.

Practical Applications

The improved citation-count method here described has two very practical applications. Primarily, it provides new criteria for selecting periodicals by pointing the way to the re-evaluation and re-establishment of such widely used lists as those which appear in Brown's *Scientific Serials* (7), as well as to a thorough review and reconsideration of all scientific serials. There is a need in this country for an official or semi-official body to lead and correlate the activities of several libraries or scientific groups in making citation and article counts, in screening citations, and in assembling, publishing, and distributing corrected lists, all in the interest of better evaluation, and consequent better use, of the scientific serial. Better evaluation is important in itself, but it acquires additional importance when the choice of journal articles for abstracting is concerned. It is apparent that not every scientific article will find its way into an abstracting journal. It is assumed that the most important articles in what are now considered to be the most important journals will, within a reasonable length of time, be included in some type of index and in some type of abstracting periodical. It is just here that the second application of this objective method of evaluation becomes apparent. Use of the method

Table 2. RPR indexes and ranks for this study and the study of Gross and Gross for the periods 1871-1925 and 1916-1925.

Journal	RPR index	Rank	
		This study	Gross and Gross study
Period 1871-1925			
<i>Berichte der deutschen chemischen Gesellschaft</i>	.022	4	1
<i>Journal of the Chemical Society</i>	.040	1	2
<i>Liebigs Annalen der Chemie</i>	.038	2	3
<i>Zeitschrift für physikalische Chemie</i>	.037	3	4
<i>Comptes rendus de l'académie des sciences</i>	.008	5	5
Period 1916-1925			
<i>Berichte der deutschen chemischen Gesellschaft</i>	.033	4	2
<i>Journal of the Chemical Society</i>	.053	3	1
<i>Liebigs Annalen der Chemie</i>	.060	1	*
<i>Zeitschrift für physikalische Chemie</i>	.058	2	3
<i>Comptes rendus de l'académie des sciences</i>	.012	5	†

* Ranked 9th of 22 journals studied. † Ranked 14th of 22 journals studied.

would minimize chance in the selection of periodical literature to be abstracted and would speed up the abstracting of material from the journal found to be most valuable.

Let us suppose that a journal devoted solely to publishing abstracts of the current periodical literature in chemistry were to limit its choice of articles to be abstracted to the five journals studied here. On the basis of RPR indexes established for the period 1871-1925, it is possible to predict with confidence the expected future ranks of these journals. The number of original articles to be abstracted from each of these journals would then be directly proportional to the ranks of the journals in the RPR indexes. Of every 100 articles to be chosen, the abstracting periodical would select 28 from the *Journal of the Chemical Society*, 26 from *Annalen der Chemie*, 25 from *Zeitschrift für physikalische Chemie*, 15 from *Berichte der deutschen chemischen Gesellschaft*, and 6 from *Comptes rendus de l'académie des sciences*. The actual choice of articles within these limits would of course remain a matter of editorial decision.

Absolute Objectivity Unattainable

Mathematical determination of the ranks of journals to be evaluated will not of itself provide absolute objectivity in the selection of periodicals to be purchased, bound, kept, or discarded. It must be related, rather, to data on such characteristics of periodicals as language(s) and country of publication, editorial policy, circulation, group or other affiliation, length and type of article, frequency of publication, generality or specialty of subject matter, and

cost. It is expected that evaluations obtained in continuing large-scale studies will reduce the importance of these characteristics as criteria of selection, but will not eliminate or cancel them entirely. The final decision in the selection of periodicals is tempered almost always by local needs and desires, and by budget limitations within the local situation. In practical applications, sound judgment as well as mathematical tabulation is needed to assure objectivity.

The results obtained in this study should be considered not as final but as indicative of the possible value of the method in the long-term evaluation of many journals. The method itself constitutes a mathematical measure of the success of any scientific journal as a vehicle for the communication of ideas. In the larger view, it may in time serve as the key to such presently abstruse problems as the value of the general scientific serial to the specialist (particularly in the field of medicine), the measurement of the effect of published abstracts upon the journals from which the original articles were abstracted, the importance of country of origin as a factor in serial selection, and the exploration and establishment of new relationships in subject fields and serial publications.

References and Notes

1. P. L. K. Gross and E. M. Gross, *Science* **66**, 385 (1927).
2. *J. Am. Chem. Soc.* **48** (1926).
3. E. Brodman, *Bull. Med. Library Assoc.* **32**, 479 (1944).
4. W. D. Postell, *ibid.* **34**, 107 (1946).
5. R. E. Stevens, "Characteristics of Subject Literatures," *Association of College and Reference Libraries Monograph No. 6* (Chicago, Ill., 1953).
6. M. B. Morgan, *Am. J. Physiol.* **191**, 416 (1957).
7. C. H. Brown, "Scientific Serials," *Association of College and Reference Libraries Monograph No. 16* (Chicago, Ill., 1956), appendix B, pp. 170-189.

Kaj Ulrik Linderstrom-Lang, Scientist, Man, Artist

If anybody ever blended the rational, the human, and the imaginative routes to understanding into a harmonious life, it was the late Kaj Linderstrøm-Lang. Seeing each of these aspects in the large, he had by nature gifts that enabled him to include them all in the picture, without the disposition, at the same time, to intrude himself into it. At a time when humanists and laymen, and even some natural scientists, began to doubt whether knowledge in the natural sciences was "worth the price"—they referred, of course, to the menace of the new, destructive nuclear forces—Linderstrøm-Lang said these simple and forceful words: "To thwart the development of knowledge in natural sciences on account of our destructive weapons would be as irrelevant as to blame Prometheus for bringing fire to Man when the straw mattress catches fire. Any human being who wants to create something new is a sort of a menace."

Lang's wisdom, courage, and imaginative power were great, and it would be difficult—and will not be attempted here—to give more than an impression of his broad personality in a general article.

Early Development

Linderstrøm-Lang was born in Frederiksberg, Copenhagen, in 1896, the son of C. F. Linderstrøm-Lang. His father was a teacher of Latin and Greek. His roots on both his father's and his mother's side went back to rural communities, and Lang's great skill in handicraft and mechanics may have stemmed from this background.

As a boy he was, like many boys, captivated by the satisfaction of making various chemical mixtures, especially those which were more or less explosive or "colorful" to the eye or nose. He liked to draw and paint. As a young

man, while studying at the Polytechnical School for a degree in chemical engineering, he wrote poetry and dramas. One of the latter was a "triangle" drama in the style of Strindberg. The influential Danish essayist and critic Georg Brandes, to whom he sent a manuscript, sent along the following letter: "By habit I use to return manuscripts without taking a glance at them. Yours I have read. It has the one virtue that it isn't dull. Whether you have talent or not I will leave you to decide for yourself." Lang decided that, since he could not feel any overwhelming literary talent in himself, he had better not count on having any, and he continued his study for the degree. He took his degree in chemical engineering, or, as he later used to say, in "ceramic engineering," in 1919. He then got a job "by chance" as assistant in the division of S. P. L. Sørensen at the Carlsberg Laboratory. Lang jokingly said later that he believed he took the job because working hours would not be too long and he hoped to use the evenings for writing and painting. But Sørensen had no interest in art and literature. He had, on the other hand, a very definite and persistent interest in science and also the ability to make young people enthusiastic. When, in addition, Niels Bjerrum entered the picture and became Lang's other teacher, retreat was out of the question. Lang became profoundly absorbed in science. Yet there were periods still when nothing in the realm of chemistry could capture his interest. He had a habit of taking up hobbies of three months' duration. But Sørensen understood the art of waiting, and he knew what he was waiting for. Gradually Lang learned to concentrate on chemistry.

Lang's duties in those days were heavy. When people in the laboratory in later years complained about routine duties, he used to tell them with a big grin that he had, during the years under

Sørensen, been made to perform as many as 10,000 Kjeldahl analyses.

In 1924, the 28-year-old chemist revealed to the scientific world that he was not only a hard-working and exact analytical chemist but a brilliant and profound physical chemist as well. In that year he published an article on the interpretation and treatment of ionization data of proteins. The theoretical approach was based on the most recent work by Debye and Hückel. The Debye-Hückel theory, only a year old, dealt with an exact formulation of the interaction between ions of low molecular weight. Lang introduced now, with supreme mastery, exact mathematical physics into the realm of protein chemistry. The extremely complicated interaction between the charged groups of polyelectrolytes was subjected to a theoretical analysis, and the influence of this interaction on the titration behavior of proteins was evaluated. His treatment of the ionization of polyvalent electrolytes is apparently still used today. It enables workers in the field of proteins to make important quantitative predictions. Indeed, the treatment by Lang was used as a starting point in Kirkwood's theory of the dissociation of ampholytes. The importance of Lang's treatment of ionization of polyelectrolytes for present-day research in biochemistry and biology has been emphasized especially by Edsall.

Lang's doctoral dissertation, which he completed in 1929, dealt with the fractionation and properties of casein and the changes brought about by the enzyme rennin. This interest in the properties of enzymes had already been awakened by a brief visit to the Willstätter laboratory in 1926.

From 1931 to 1932 Lang studied in the United States as a Rockefeller research fellow. He studied general biology with the late Thomas Hunt Morgan and chemistry and biochemistry with Linus Pauling and Henry Borsook. This visit to California meant much to Lang, both scientifically and from a personal point of view. In 1938 Sørensen retired and Linderstrøm-Lang was selected as his successor as the director of the chemical laboratory at Carlsberg.

The Linderstrøm-Lang-Holter Micromethods

From 1932 to 1935 Lang's endeavors were focused on a new and ambitious

project, the development of ultramicro methods of localizing enzymes among different types of cells in organs and even within single cells. In this plan he was undoubtedly greatly inspired by his close friend Heinz Holter, who had joined the laboratory. All the micro tools had to be "tailored" to the requirements of the project, and Lang and Holter used imaginative and very simple means. The Cartesian diver for the determination of ultramicro gas exchange was one of the best-known and most ingenious of these devices. This method, further refined by one of their pupils, Erik Zeuthen, enabled them to follow metabolic changes during the divisions of a fertilized amphibian egg. Another particularly noteworthy device was the specific gravity gradient tube (consisting of two mixtures of bromobenzene and kerosene) with the floating micro drop. This method permits the detection of minute (1×10^{-6} gm/ml) differences in the density of an aqueous solution as well as the detection of incredibly small amounts of proteolytic enzymes or other esterases. When a closely linear density gradient is established, drops are allowed to fall through the gradient. As is well known, the level at which the drops come to rest determines the density of the unknown solution. If the rate of fall is taken into account, one can even follow the catalytic action of esterases, such as peptidases, which produce minute density changes in the medium during catalysis. These changes are due to the hydrolysis of esters and acid anhydrides, around neutral pH, which liberates charged groups and thus brings about a packing of water molecules around the charged particles (a process known as electrostriction).

The methods which were used in the Carlsberg Laboratory rapidly spread to many other laboratories and made possible a great number of fundamental investigations, including determination of the location of enzymes in various cells or within a single cell.

Lowry's survey of nutrition in infants and children was based on these specialized and sensitive micro techniques. The Cartesian diver method furnished, as I have mentioned, new information about the development of cellular respiration in the dividing egg cell. All the methods are more or less novel in approach. They attracted the interest of innumerable scholars from all countries and will probably be admired for their simplicity of design by scientists in generations to come.

Molecular Dynamics of Proteins

In the late 1930's Lang returned to his main interest, the structure of proteins. His interest went beyond what he called the primary structure—that is, the amino acid sequence—although he always thought that this sequence governed the establishment and determined the type of a secondary structure. Lang's attention was focused on the interaction of the hydroxyl and sulfhydryl groups with neighboring groups in the same chain and with groups in other chains and, of course, with the α -helix. He furnished evidence for the breaking of hydrogen bonds in the globular proteins as the initial step in the enzymatic hydrolysis of peptide linkages.

Experiments with C. F. Jacobsen indicated that even in the conversion of chymotrypsinogen to chymotrypsin (especially to Jacobsen's highly active π chymotrypsin) a reversible denaturation process is involved. Moreover, in the splitting of α -lactoglobulin by trypsin a peculiar temperature effect was observed. By recording volume change (ΔV) versus mole peptide bond split, they observed that an initial process necessary for the opening of the protein molecule prior to the attack of the endopeptidase ("predenaturation") is relatively more rapid at 0° than at 30° or 40°C. With Jacobsen and Korsgaard-Christensen, Lang also studied the reversible denaturation of α -lactoglobulin brought about by urea. This process was followed by chemical and physical methods. The latter involved volume changes and optical rotation.

Lang described the reversible denaturation provisionally as an equilibrium between two states of the protein L_s , which is relatively stable, and L_i , which is unstable and denatures readily and reversibly. L_s predominates at higher temperatures; L_i , at lower temperatures. These notions, which originated as early as 1937-38 from his work with Hotchkiss and Johansen, probably played a significant role in the planning of his last experiments, on deuterium exchange.

It seems natural to mention Lang's last contribution at this point because there was so close a connection between it and his work on protein denaturation and changes of secondary structure, a field Lang in his latest years referred to as "molecular dynamics." I am referring to his bold ideas and his subsequently successfully established techniques in connection with the two types of pep-

tide-bonded hydrogen in proteins—the free, and those more or less engaged in hydrogen bonding. The latter, he thought, although bound to nitrogen, might not exchange instantaneously with water. Hence, it should be possible to distinguish between those parts of a protein which are permanently or frequently in a hydrogen-bonded phase and those which possess only a primary structure. This idea had become particularly meaningful after Sanger's complete amino acid analysis of insulin and the subsequent extensive analysis of ribonuclease by American workers. Harrington and Schellman, during their stay in Lang's department, had concentrated on the stability of peptide hydrogen bonds in aqueous solution, using native and oxidized ribonuclease as models. These studies heightened the importance of the deuterium studies. Moreover, they provided an independent technique complementary to that of hydrogen exchange.

The design of the deuterium-exchange studies was not easy since it required many small samples of deuterium-loaded protein (deuterium being exchanged for the hydrogens bound to nitrogen, oxygen, and sulfur) as well as rapid handling and highly sensitive methods. Lang felt that his ultramicro deuterium technique with the specific gravity gradient tube was the answer. The outcome of this important work is well known. He showed that in most cases the establishment of the α -helix as a permanent structure (or another type of secondary structure) requires the cooperation of the so-called tertiary structure. Lang would have been the first to mention that the success of the various physical methods used in this project was due to the contributions of a large group, including visitors from many foreign countries. Yet he himself spent days and nights on the tricky work required to get the technique on an exact and reproducible basis. In insulin and ribonuclease, the deuterium technique illustrated particularly well that of the two classes of peptide hydrogen, one group exchanges instantaneously with water and the second exchanges at varying velocities, but relatively slowly. The A chain of insulin or the "unsupported" ribonuclease (resulting from peroxidation of S-S bonds) are devoid of a permanent α -helix or any other permanent secondary structure, and all of the peptide hydrogen exchanges instantaneously with water. A most elegant study of one of the syn-

thetic polypeptides prepared by Katchalski's group, poly-DL-alanine, adds further knowledge about the nature of "motility" of proteins, as Lang called the rate of exchange of peptide hydrogen. He did not hide the paradox that polyalanine without any obvious tertiary structure (seemingly like oxidized ribonuclease or the A chain of insulin) exchanges a part of its peptide hydrogen relatively slowly. He assumed that a special "intrinsic" stabilizing factor is at work here—namely, that of hydrophobic bonds between methyl groups of D- and L-alanine residues, which are presumably distributed at random. The average distance between neighboring D and L hydrophobic groups in a polymer of this type would correspond to that of liquid methane. The random distribution of D- and L-alanine was shown by Lang from the behavior of the polymer toward leucylamino peptidase or carboxypeptidase, the action of which stops whenever a D-alanyl residue is encountered; that is, only one-half to one peptide bond per mole is opened.

An interesting study of the rate of exchange of peptide hydrogen in crystalline myoglobin followed. It was shown that in addition to the slowly exchanging hydrogen there was a small part which did not exchange, even at pH 7. This fraction could be induced to exchange in a weakly alkaline reaction; a pH of 8.5 would suffice to bring about an exchange. The possibility that this group represents histidine residues involved in the coordination of the heme group was discussed.

So much for Lang's introduction of "molecular dynamics" and "motility" as important disciplines into the biochemistry of polymers. These are already classical pioneer studies. The student is referred to Linderstrøm-Lang and Schellman's most recent discussion of these problems in the new edition of *The Enzymes*. Here Lang gives the general essence of the problems in a concentrated and powerful form. The reader will find comparatively little reference to and discussion of Lang's earlier denaturation studies in this article. It bored him to repeat himself or to "lobby" for his own work. He wanted renewal, fresh ideas, and relentless sober evaluation. A number of our important problems in molecular biology (including biochemical genetics) are summed up in this paragraph from the review: "The important point is that the ordering forces of the peptide hydrogen bonds appear

to be slightly over-compensated by the entropy of unfolding so that the final decision rests on the side-chain interactions which depend themselves on the nature and sequence of the amino acids present. Since sequences are in general quite aperiodic these forces will be favorable in one part of the molecule, unfavorable in another, so that the protein molecule will often consist of a number of regions of varying structures and stability. . . ."

Discovery of Subtilisin;

Study of Catalytic Centers

I have yet to review two other lines of development initiated by Lang. The discovery of the enzyme subtilisin and its many fascinating activities was, according to Lang, facilitated by a tradition at Carlsberg stemming back to Sørensen, and that was, never to throw anything away. A half-year-old sample of ovalbumin which did not smell too bad because it was covered by kerosene was worked up by Martin Ottesen, who obtained some "queer crystals"—rather large plates. Ovalbumin crystallizes in needles. Lang and Ottesen decided that the "strange" observation was worth some time and labor. They soon found that the conversion of ovalbumin to "plakalbumin," as they called the novel protein, was due to an enzyme from *Bacillus subtilis*. Subtilisin, as it was called, was found to catalyze the liberation of a peptide from ovalbumin through a process much like chymotrypsinogen activation. The protein moiety had an electrophoretic mobility different from that of ovalbumin (Perlmann). The amino acid sequence of the peptide was studied. For this purpose a technique somewhat different from Sanger's was used—the formation of dithiocarbamate between added carbon disulfide and the terminal amino group. This interaction liberates hydrogen ions. By continuous addition of base to keep the pH constant, the process can be followed quantitatively. This prompted the idea of constructing the pH stat, which is now used widely all over the world.

From the plakalbumin-subtilisin interlude came other important work, such as a study of the nature of the catalytic centers of proteins. There is, for example, the enzymatic splitting of ribonuclease (Richards and Anfinsen). Certain subtilisin preparations act in such a fashion as to split a polypeptide

segment from ribonuclease. Subsequent mixing of the two separated, inactive components can restore enzymatic activity (Richards).

Biosynthesis of Proteins

Finally, I must mention an area to which Lang made important contributions as a theoretical biochemist, and that is the problem of the mechanism of biosynthesis of proteins. Lang was equally interested in the Bergmann-Fruton-Hanes approach of transpeptidation and the Lipmann-Chantrenne approach of coupled reactions. Concerning the transpeptidation, he pointed out that it is misleading to give any kind of "standard value" for the free energy of hydrolysis of a peptide bond. The ionization constants (at a constant pH around neutrality) are highly important, and these constants are again strikingly influenced by the presence of electrolytes (see Lang's work of 1924). In the most favorable case, the uniting of two long peptide chains, the ΔF of the hydrolysis is as low as -1160 calories (a dipeptide has a ΔF of hydrolysis of -4100 calories). In the coupled reactions, the discovery of acylphosphate, and especially Lipmann's acetylphosphate, were guiding events for some of the planning on experimental studies on peptide biosynthesis at Carlsberg. Chantrenne, who worked at the Carlsberg Laboratory in 1947 and 1948, developed several elegant model reactions, the importance of which Lang emphasized strongly. Chantrenne's work is the first demonstration of the importance of disubstituted acyl compounds in the synthesis of peptide linkages. Lang mentions also in his *Lane Medical Lectures* (page 106) that Chantrenne drew attention to the possible importance of nucleic acid in the transfer of acyl groups to amino groups because of their rich content of singly and doubly esterified phosphate groups. This was pointed out as early as 1948 in Chantrenne's article in the Carlsberg publication. Lang may have taken pleasure in the later discoveries of adenylation and ribonucleic amino acid complexes by Hoagland, Zamecnik, and Berg. Hoagland was a former Carlsberg pupil. The field of coupled metabolic reactions was relatively unfamiliar to Lang, but he admired the development here very much. He reminded the metabolically minded biochemist that a major factor

in the large ΔF of hydrolysis of acid anhydrides is the release of protons and the establishment of a large concentration gradient with respect to protons; we live, after all, in a very dilute "atmosphere" of protons.

Beer, Rockets, and Other Fireworks

During his 21 years of directorship at Carlsberg, Lang's laboratory was visited by an immense number of brilliant scholars, young and old, of every nationality. He played also a great role in the careers of young Danish scholars in the natural sciences and in the field of medicine.

Although Lang lived in the villa attached to the institute, he always joined in the daily lunch in the laboratory. The common American myth that there were special pipelines from the Carlsberg breweries to the Carlsberg laboratories need not be discussed here. The fact was that the members had access to many interesting kinds of beer, including the powerful Easter brew, and the Stout porter, besides, of course, the popular daily pilsner "Hof." Lang was not bothered in any way by a bottle of strong brew, even in the middle of the day. He and Holter used to wrap the tin foil of the cap around Danish "Tordenskjold" matches, which were then allowed to ignite on the launching site, the top of an empty bottle of "Hof." The "Carlsberg rocket," which emitted a vigorous sulfhydryl scent, traveled well beyond the boundaries of the lunchroom. Among the topics of conversation at these daily symposia were science, literature, politics, puns, and good stories. Of the latter, Lang had a huge arsenal; his stories possessed not only wit but a humor characterized by warmth and freshness. His delightful rendition of a grotesque poem about the feeling of thirst for beer, which he translated into English himself, "When the beerhound howls," will be long remembered.

Lang was certainly a complex and many-sided person. He showed amazingly little interest in building up his own reputation, hence people learned to appreciate his power and greatness rather slowly. As one of my friends, referring to Lang's modesty, expressed it: "It is possible that some people saw him as less great than he was, simply because he was so aware of the enormity of the things outside of himself."

Scholar and Statesman

Lang was elected a member of the Royal Danish Academy in 1935. Later, innumerable other high academic honors were bestowed upon him (1). He was an active member of many important commissions for the promotion of science and technology in Denmark and of international commissions on science and education. Lang was chairman and later president of the Danish Academy for Technical Science. He never forgot that he was an engineer by training and constantly took an interest in the basic education of young Danish engineers. A source of constant inspiration for

him was the work of I. C. Jacobsen, the founder of the Carlsberg breweries and of the Carlsberg Foundation, who was not only an ingenious brewer, but also a devoted public servant. Lang felt that Jacobsen's idea and work for the support of basic sciences through the Royal Danish Academy had produced one of the earliest examples of a wisely organized scientific council. It was only natural that Lang later should become an influential member of the Danish State Scientific Council. He emphasized on many occasions his particular debt and gratitude to the Rockefeller Foundation.

Lang had a unique ability to com-



Kaj Ulrik Linderstrøm-Lang

municate with people of all professions, and he was very much the wise statesman, not the least in international scientific and educational affairs. He possessed leadership, supreme ability to make just evaluations, and idealism. He was one of the founders of the International Union of Biochemistry and was elected president of the union in 1958. Great initiative and hard work were required to establish this union, and Lang carried one of the main burdens.

His assignment as guest professor and lecturer at the Rockefeller Institute in New York in 1957 meant much to him, for it provided contacts with American students and a chance to meet distinguished scholars. Lang was also a popular participant in the Gordon Research Conferences in Proteins. The most recent of these meetings was dedicated to his memory. His stay at Stanford University as Lane lecturer will also be recalled.

Linderstrøm-Lang was never a pessimist, not even when it came to the question of mankind's survival in an atomic age. However, he was far from being a light-hearted optimist in this matter. He felt a rationalistic approach is necessary in any case, but he also felt that a much more revolutionary and fundamental human approach must be found before man can hope for a great future. He greatly favored extending friendship toward scholars from behind the Iron Curtain. But he insisted that this should be true friendship and that these scholars should not be treated with an unnatural reverence. They should have an opportunity to see the many unplanned and funny happenings as well as the serious sides of life in another country. Many of them are persons who are deeply interested and fully able to absorb such impressions. Lang established friendships with several Russian scholars in the field of physics, chemistry, and biochemistry and valued these contacts highly.

He was, as I have mentioned, scheduled to serve as president of the International Congress of Biochemistry in Moscow in 1961 and looked forward to this event very much. Lang, Maaløe, and Westergaard had arranged an international symposium on genes and the specificity of proteins, to be held in September 1959; Lang was to have been general chairman. When I visited him in early May he was, in spite of severe suffering, occupied with plans for this meeting.

Linderstrøm-Lang was, in the deepest sense of the word, a philosopher, seemingly rationalistic if one did not know him, but essentially a supreme humanist and artist. It is true that the scientific way of evaluating life was basic to his nature. His description of Sørensen's reaction to a spiritualist meeting is a classic. "As a matter of fact, to talk reason ought to be natural for a scientist. Not because scientists are more reasonable by birth than other people, but because science is reasonable, science is rational. I really think that it should have a mission here. In order to show what I mean, permit me to tell a story about my most beloved and admired teacher and predecessor at Carlsberg, S. P. L. Sørensen. Sometime in his middle-age he took part in a spiritualistic session. Where and why has escaped my memory. But there he sat at a table together with a group of others—quite distinguished people, so he told me, and most of them disbelievers like himself. In the course of the evening the circle succeeded in producing several uncanny raps while a weird and ghostly atmosphere pervaded the room. One of the participants left the table and was set to guard a purse which contained an unknown sum of money. The spirits were then supposed to tell the magnitude of the sum—only the number of crowns, I think, because after all the means of communication, the table-legs, were imperfect. The table rapped 9 times, and sure enough there were 9 crowns in the purse, neither more nor less. The light was dim, the bookshelves creaked, the wind whined in the chimney, and the people present were more or less prepared beforehand through eery stories of ghosts in other sitting rooms. I was therefore inclined to believe Sørensen, when he told me that everybody got pale around the gills and wanted to go home to bed after this first encounter with the transcendental. But Sørensen said the divine words: 'Now we do this 10 times,' and actually forced the participants to repeat the experiment again and again. The result was entirely negative—which of course may have been luck in the opposite direction. But that is not the point of the story. Its moral, as I see it, is the victory of scientific reasoning and method over emotional evaluation. In everyday life we are all too frequently satisfied with our own judgement based upon entirely insufficient observations and coloured by our personal fancies. In a wider connection it is the

appeal to rationalism and even to tolerance which I find so stimulating in Sørensen's story."

To refer to Lang's words about Prometheus, there is no doubt that he considered science thoroughly healthy for the human mind. And how he pursued it for at least 40 years! Perhaps he loved mathematical physics more than anything else. Statistical mechanics and quantum mechanics were in many ways the *basso continuo* in his thinking (see his little humoresque about the "Statistical mechanics of houseflies"). Bohr's words about complementary and holistic features of elementary particles were notions Lang frequently emphasized in his wonderfully written short essays about science and society. He agreed with Bohr that predictions about individuals are made meaningless by the inevitable interaction with the investigator, quite apart from considerations of the essence of the individualistic features. Lang believed that the future of society as a whole might, however, be described on a statistical basis, although he said that he did not envy the social scientists when it came to deriving laws of society from history and social experiments. English and American history interested him greatly, especially the periods of Jefferson and Lincoln, during which ideas, lofty as well as realistic, developed. As an individual he genuinely understood the ancient and lasting truth that we are both spectators and actors in the great drama of life. He reminded us that a renunciation of laborious scientific self-discipline leads easily to cheap mysticism, intolerance, and race prejudice, and that that is the road to hatred, cynicism, and destruction.

Linderstrøm-Lang was a man of strength, warmth, and profound imagination but not of illusions. During the hectic 1930's he felt intensely that soon he would be called upon as an actor in the great drama. He joined the young men of the Danish resistance movement during the Nazi occupation of Denmark. From the beginning he was a dedicated fighter against Nazism, which he felt to be one of the major scourges of mankind. In 1943 he was taken from his home to a prison of the occupation force and kept there for several weeks. When he had occasion to refer to these events later, he did so good-humoredly. But the fate of children and of peaceful people destined to be eliminated, and of the upright Danish people, young and old, who paid

with their lives in this fight, made a lasting impression on him. He admired the rebellion of the individual on behalf of "life" more than anything else, and his admiration was far from passive. That is why it warmed his heart to see a number of American scholars stand up on behalf of their Constitution during the spell of political neurosis in America five or six years ago. During this period Lang used to tell his many American friends that, along with the Four Freedoms, there is one very precious freedom that America must not lose, and that is a young man's freedom to make a "goddam fool of himself." He had a special liking for young men and women who were not afraid or ashamed of groping in their search for understanding. No wonder that he won the undying admiration of his students. Lang did not have any illusions, either, about the nature of the suppression of thinking in Communist states. Every instance of enforcement of "ideological biology," he felt, was a threat to the future.

Lang was in many ways a poet; his language was sensitive, subtle, and deeply humorous. It could express rebellion, but it could also, and more often did, express sublime ideas, and it always had warmth. He was as fluent in English as

in Danish, and his love for British and American slang added warmth and color to his lectures delivered in Great Britain and the United States. He and his wife Gerda radiated unlimited generosity and hospitality. Lang had the "gift of feast." Their friends will long remember the songs and speeches at the colorful dinner parties in their beautiful home. He particularly loved humor in art. Among the songs he could be persuaded to perform were Danish folksongs, Bellmann's songs, drinking songs, and romantic songs. Above all else he loved the music of Mozart and Schubert, and as a violinist, he was an enthusiastic and spirited performer of chamber music; especially with his friend Thomas Rosenberg, whose fine musicianship he admired so much. Lang was a painter of special talent, being influenced by modern Danish painters and by Cezanne. His home contained many fine works of his own creation, and he was generous in giving away his fine paintings.

Spirit, generosity, and courage are qualities that will always be associated with the Lang family. Never were they worried about security for themselves. Lang possessed in full measure the spontaneity to help those who needed comfort and encouragement. He had no fear of opening his heart and sharing

other people's sorrows and tragedies, although this surely added burdens to his own life. This combination of wisdom and compassion was unique. How many of us can expect to know a person of his stature in our life-time?

We who knew him will always remember his poetical and at the same time boyish face, with the warm smile and the deep blue eyes. His photograph catches something of his expression—a great light from a depth of laborious and unlimited human experience and understanding. His death is an immense loss to a large international community of scholars and students.

HERMAN M. KALCKAR

*McCullum-Pratt Institute and
Department of Biology,
Johns Hopkins University*

Note

1. Linderström-Lang was a member of the Royal Danish Academy of Arts and Sciences; a foreign member of the National Academy of Sciences (U.S.), the American Philosophical Society, the Royal Society (London), the Academy of Sciences of the U.S.S.R., and the Karolinska Institute (Stockholm); and a council member of the Institut International de Chimie Solvay. He received honorary degrees from the Universities of Copenhagen, Oslo, Ghent, and Brussels; New York University; Cambridge University; and the Polytechnic School of Copenhagen.

Science in the News

Student Loyalty Oaths: Chances Nil for Outright Repeal; Compromise Possible

The attempt to repeal the affidavit requirement of the federal student loan program should reach a climax in the Senate very soon, perhaps next week. This is the affidavit which requires students, in order to be eligible for a loan, to swear they do not believe in, support, or belong to a subversive organization. The students are also required to take a loyalty oath ("to support and defend the Constitution"), but it is the affidavit

requirement that has led nearly 30 colleges to withdraw from the program and many more to issue formal protests.

A year ago a bill to repeal both the oath and affidavit requirements was brought up in the Senate. During the debate its sponsors, Senators Kennedy and Clark, reluctantly accepted amendments reinstating the oath and attaching a penalty for taking it under false pretenses. Senator Mundt had offered a substitute measure which also did away with the affidavit but which made it a crime for members of subversive organizations to accept loans. Kennedy and

Clark refused to go along with this. They gambled on passing their bill without further compromise and lost by the fairly close vote of 49 to 43.

This year Kennedy and Clark will bring up a bill similar to the amended version of last year's, eliminating the affidavit but including a penalty for falsely taking the oath. They say they are optimistic about its chances of passage in the Senate, but a good many people find it hard to locate the source of this optimism. For the bill failed last year, and although supporters say that the colleges have recently been more active in applying pressure to Congress, it is always more difficult to pass this sort of law in an election year.

Outlook in the Senate

At this writing the feeling on Capitol Hill seems to be this: Kennedy and Clark will make a fight for their bill, but they will end by going along with an amendment by either Senator Mundt or Senator Prouty making it a crime for a member or supporter of an organization he knows to be subversive to ac-



Senators John F. Kennedy (D-Mass.) and Joseph S. Clark (D-Pa.), sponsors of legislation to repeal the affidavit requirement of the federal student loan program. (Right) Senator Winston S. Prouty (R-Vt.) who plans to offer a compromise proposal.

cept a loan. This is a compromise, of course, but a compromise which seems to be acceptable, if not satisfactory, to almost everyone—from the schools which have withdrawn from the program because of the affidavit (which seemed to them to imply, much more forcefully than the oath, that the loyalty and beliefs of American students need questioning) to the American Legion, which would like to see the affidavit requirement kept, but which, in a letter to Senator Mundt last year, appeared to be willing to accept Mundt's compromise without stirring up a fuss.

The senators who, with Kennedy and Clark, dislike such a compromise do so on the grounds that no good can come of attaching little re-enactments of the Smith Act, which is what they say the Prouty or Mundt amendments would amount to, to bills which have no substantial connection with the security of the country. And, in particular, they object to the state of mind which singles out needy students and implies that they are especially in need of watching.

As for the loyalty oath itself, no one denies the argument, advanced by its proponents, that it is an oath that any American should be proud to take. It is, in fact, the same oath that is used at the induction of new citizens and essentially the same as that taken at the swearing in of members of the armed forces, government officials, and Con-

gressmen, and at the inauguration of the President himself. Its opponents have nothing against the oath, which is simple and eloquent and was in essence written into the Constitution by the founding fathers. They merely point out that it is, on several grounds, simply inappropriate to the occasion of a young man borrowing some money.

Meanwhile there is virtually no one in the Senate who is wholly immune to the argument that there is something wrong with a law that requires a student to stand up and swear he is not a subversive before he is eligible for a loan. This is a substantial change from the situation as it was only a few years ago, and neither Mundt nor Prouty see any substantial opposition in the Senate to their versions of the affidavit repeal legislation.

The Real Fight

The real fight will come in the House, where Graham Barden (D-S.C.), chairman of the Education and Labor Committee, is opposed to any change in the law, explaining that he has been taking oaths since he was a boy scout, which was a long time ago, and it has never done him any harm. Howard Smith (D-Va.), chairman of the powerful rules committee, is also cool towards any change.

Carl Elliot (D-Ala.), Majority Leader McCormack, and apparently Speaker Rayburn have all taken the same position: that while they would favor elimi-

nating the affidavit, they regard it as an essentially unimportant matter and they have no intention of diverting any part of their time or bargaining power to it at a time when they are trying to push through more important legislation, such as federal aid to education.

The House is much more tightly controlled by its senior members than is the Senate. With the key figures there either actively opposed to the bill or, at best, passively in favor, the outlook in the House for the Kennedy-Clark bill is, therefore, dismal in the extreme. But Edith Green (D-Ore.), James Roosevelt (D-Calif.), and Peter Frelinguysen (R-N.J.), members of the Education Subcommittee, have all been pressing Chairman Elliot to at least attempt to get action on a repeal bill past Barden. They would all be delighted to accept the Mundt-Prouty compromise rather than no action at all. And Barden himself last year went along with a similar compromise on the labor bill. This eliminated the non-Communist affidavit requirement from the Taft-Hartley Act but substituted a clause making it a crime for a Communist to be a union official, or, as the liberals insisted on adding, a management official either.

So the situation appears to be this: If neither the Kennedy-Clark nor the Mundt-Prouty proposals pass the Senate the issue is dead for this year. But if either passes the Senate, the outlook for the Mundt-Prouty compromise in the House will be at least hopeful. The

outcome at best will be a compromise. But, if it comes about, it will be a meaningful compromise. It will supply the proponents of the oath with the token assurance they regard as important that the Defense Education Act will not serve as a source of financial support to such disloyal students as there may be. It will supply opponents of the oath with the more substantial gain that needy students will no longer have to swear they are not planning to overthrow the government before they can be eligible for a loan.

Test Ban Research: Program Calls for More Than Double Planned Spending

The White House last Saturday released an outline of a greatly expanded program to improve the system for detecting underground nuclear explosions. The program showed a heavy increase in planned spending not only over this year's \$10 million pilot program, but over the program (roughly \$30 million) discussed at the test ban hearings on Capitol Hill last month.

The new program calls for spending \$66 million in fiscal 1961. An unspecified but large proportion of this money will go into preparing and carrying out a series of underground conventional and nuclear test explosions. There is, of course, no fallout or health menace from such explosions, and it is partly the very fact that all radiation from underground tests is confined within a small space deep underground that makes enforcing a test ban so difficult.

The Russians agreed to the use of nuclear as well as chemical test explosions last week. A series of scientific meetings was scheduled to start Wednesday (11 May) to begin working out the details of a cooperative research program with the Russians, including the touchy problem of developing a system to assure the rival powers that no one is using the research program to gather data useful in weapon development.

Timing of the Announcement

The timing of the White House announcement, combined with the haste of the press services in getting the story on the wire, led to headlines suggesting that the U.S. planned to resume tests outside the international research program and to speculation

that the announcement was intended as some sort of reprisal to the Russian's shooting down an American plane. None of this was helped by the phrasing of Presidential Press Secretary James Hagerty's remarks intended to clarify the official announcement. In an apparent effort to emphasize the peaceful character of the tests, Hagerty succeeded only in generating news stories linking the proposed explosions to the U.S. atoms-for-peace program. As a result the State Department had to issue a hasty announcement pointing out that the tests were only those the Russians had agreed to and had no connection with the Project Plowshare tests the Administration has had under consideration for some time.

A year ago the Berkner Panel had recommended that some nuclear explosions should be made as part of the detection research program. The White House announcement simply indicated that we were planning to go ahead on our own proposal, now approved by the Russians.

Nuclear vs. Conventional Tests

There are clear advantages in using atomic explosions in a research program designed to find ways to detect such explosions. You would need to build a chamber the size of a large office building 2000 or 3000 feet underground to hold 20,000 tons of TNT for a test explosion. A nuclear device of the same yield could be lowered down a hole 30 inches in diameter. But aside from such practical considerations, it is believed that the strength and patterns of shock waves from nuclear and chemical explosions are not identical. It may turn out to be fairly easy to use chemical explosions and to extrapolate the strength factor to get results equivalent to a nuclear explosion. There is much less likely to be a workable way to extrapolate the wave patterns, and it is the detailed analysis of the wave patterns that offers one of the most hopeful means of distinguishing nuclear explosions from earthquakes.

What the scientists want to learn is, first, how do the seismic reactions of nuclear and chemical explosions differ, if, as is suspected, they do differ? Secondly, how can nuclear blasts be distinguished not only from earthquakes but from large conventional explosions, such as those used in mining operations? Tests with both nuclear and conventional explosives will obviously be needed to answer these questions.

After long consideration the Russians last Wednesday finally agreed that nuclear tests would be necessary. But to the general public a nuclear test is a nuclear test. That the U.S. plans to explode some nuclear devices makes more of an impression than the distinction that these will be part of an internationally agreed to program and will be underground tests from which there is no fallout. So it is understandable, if nevertheless unfortunate, that the nuclear tests rather than the research program should have gotten a major share of the headlines.

Advanced Research Projects Agency

Regarding the size of the program, both Hans Bethe, the leading scientific backer of the test ban, and Edward Teller, its leading opponent, have strongly recommended a greatly increased effort in detection research, as have the members of the Congressional Atomic Energy Committee. It was fairly well known that the Administration was working out a program calling for substantially more spending than that outlined before the committee 3 weeks ago.

While the details have not been released, the program is expected to draw on the experience developed in the oil and gas industry, where analysis of the shock waves produced by test explosions is used to help locate oil bearing strata, and on government offices such as the Coast and Geodetic Survey and the Bureau of Standards. The Survey will be used in gathering data on the frequency of earthquakes in various parts of the globe, the Bureau in developing more precisely calibrated and generally improved seismographs. But administration of the program will be in the hands of the Advanced Research Projects Agency, a special research group within the Defense Department which reports directly to Herbert York, director of defense research and engineering, and to the Secretary of Defense. In the past ARPA has been used to get high-priority projects under way, after which they were transferred to one of the services for further development, although there is no intention of doing this with the seismic research program.

ARPA will handle the entire test detection program (Project Vela) which includes not only the seismic research for underground tests, but development, still in the pilot stage, of systems for detecting explosions millions

of miles in space; such space shots, including, of course, the instrumentation to send back data, are theoretically possible today and are expected to be practical within a few years.

Civil Service Raises Pay for Scientists and Engineers

On the basis of findings of its annual survey of government and industry experience in the recruitment of employees in shortage-category fields, the Civil Service Commission has announced that minimum pay rates for engineering and certain kinds of physical-science positions will be raised to the top of grades GS-5 and GS-7—\$4940 and \$5880, respectively. The higher rates, for new employees and for employees now holding such jobs, become effective with the first pay period in May. The commission is authorized to raise pay rates within Classification Act pay grades when the government is at a competitive disadvantage with private employers and the federal need is acute.

The adjustments are expected to aid the government in recruiting about 3200 engineers and 1200 scientists during the next year, at an estimated additional cost of \$1,980,000. Approximately 8700 engineers and scientists now serving in affected positions will have their pay adjusted under the new formula, at an estimated first-year additional cost of \$2,214,900. Current rates of pay for these positions are \$4490 at grade 5 (4th step) and \$5430 at grade 7 (4th step).

The CSC's latest study showed a decrease in acceptance rates by persons offered federal employment in these shortage-category occupations and a widened gap between industry's median starting pay and the rates government agencies could offer for these jobs. Evidence also is accumulating that private employers will offer still higher salaries to June 1960 graduates in these shortage fields.

Recruitment Drops in Both Areas

While the 1959 engineer-scientist acceptance rate—the percentage of acceptance of firm offers of appointment—decreased for both government and industry recruitment, the decrease was greater for government than for industry. Industry's acceptance rate in 1959 decreased only 3 percent—from

46 percent in 1958 to 43 percent in 1959; government's acceptance rate decreased by 5 percent—from 40 percent in 1958 to 35 percent in 1959.

The decrease in acceptances of federal employment was sharper for engineering positions (from 37 percent in 1958 to 31 percent in 1959) than for physical-science positions (from 49 percent in 1958 to 45 percent in 1959). The commission points out that the government's recruiting efforts actually were less fruitful than the statistics reflect because many of the top-quality engineering and physical-science candidates interviewed by federal recruiters indicated their disinterest, primarily because of salary, even before an offer of employment could be made and therefore were not recorded in the acceptance-declination tabulation.

Positions covered by the CSC action include all professional engineering positions in grades 5 and 7 and positions at those grades in the following Classification Act occupational series: architecture, landscape architecture, patent examining, patent adviser, physics, geophysics, chemistry, metallurgy, astronomy, meteorology, geology, geodesy, actuary, mathematics, oceanographer (physical), mathematical statistician, and technologist (eight specific specialties).

Academy Radiation Committees Issue Reassuring Reports

The National Academy of Sciences-National Research Council has issued a set of summary reports by its six Committees on the Biological Effects of Atomic Radiation, supplementing the committees' original reports published in 1956. An accompanying "Report to the Public" states, in an introduction: "The steady accumulation of scientific information since 1956 has not brought to light any facts that call for a drastic revision of earlier recommendations."

The "Report to the Public" also notes, among a number of considerations that prompted publication of the supplementary reports, the broadening uses of atomic radiation for peaceful purposes and the intensifying public concern with the resulting hazards. Some of the committees' findings are as follows.

There is some new evidence that genetic effects from low radiation doses may be less than previously estimated.

The committee continues to recom-

mend that the average gonadal dose for the general population during the first 30 years of life not exceed 10 roentgens of man-made radiation, and that it be kept as far below this level as is feasible.

There is experimental evidence to show that radiation-induced tumors do not begin to develop immediately after the radiation has been absorbed.

No new evidence has appeared to show that nuclear tests have affected the weather.

The significant long-range effects of the presence of radioactive isotopes in foodstuffs have yet to be determined.

The disposal of radioactive wastes has not resulted in any significant hazard to the public, its environment, or its natural resources.

There is nothing inherent in the radioactive-waste control problem requiring restriction of the nuclear-energy program, provided adequate measures are taken to protect public health and safety.

Present indications are that limited quantities of radioactive materials can be safely released in the oceans.

The six academy committees cover the fields of genetics, pathology, meteorology, agriculture and food supplies, disposal and dispersal of radioactive wastes, and oceanography and fisheries. Appointed in 1955 by Detlev W. Bronk, president of the National Academy of Sciences, they were asked to conduct a continuing appraisal of the effects of atomic radiations on living organisms and to identify questions on which further intensive research was urgently needed. From the outset, the work of the committees has been supported by funds provided by the Rockefeller Foundation.

AAAS Theobald Smith Award in the Medical Sciences

The Theobald Smith Award of \$1000 and a bronze medal, which has been given yearly since 1937 (except for a lapse during the war years) by Eli Lilly and Company of Indianapolis, under the auspices of the American Association for the Advancement of Science, will be given at the association's 127th meeting in New York, 26-31 December. Travel expenses will be paid by the donors to enable the recipient to receive the award in person.

Nominations are now being requested for the award. They may be made by

fellows of the AAAS and should be sent to the Secretary of the Section on Medical Sciences, Dr. Allan D. Bass, Department of Pharmacology, Vanderbilt University School of Medicine, Nashville 5, Tenn.

The prize is given for "demonstrated research in the field of the medical sciences, taking into consideration independence of thought and originality." Any investigator who was less than 35 years of age on 1 January 1960, and is a citizen of the United States, is eligible. The research is not to be judged in comparison with the work of more mature and experienced investigators.

Nominations must be received before 1 September. All nominations should be accompanied by: (i) six copies of a two-page summary in the form of a letter of nomination which details the importance of the candidate's work; (ii) six copies of any manuscripts ready for publication; (iii) six copies each of reprints of the candidate's more important published articles; and (iv) six copies of a biographical sketch of the candidate.

Recent recipients of the award have been: 1953, Irving M. London, Albert Einstein College of Medicine; 1954, Winston H. Price, Johns Hopkins University; 1955, Robert A. Good, University of Minnesota School of Medicine; 1956, Oscar Touster, Vanderbilt University School of Medicine; 1957, Paul Talalay, University of Chicago; 1958, Albert Sjoerdsma, National Heart Institute; and 1959, William F. Scherer, University of Minnesota Medical School.

High-Altitude Research Facilities Available

The National Science Foundation has made a grant to the University of Denver to assist in the maintenance of the Inter-University High Altitude Laboratories. The grant assures the availability to U.S. scientists of the laboratory facilities at the top of Mount Evans, Colorado (elevation 14,150 feet) and those at Echo Lake (elevation, 10,700 feet). The University of Denver administers the laboratories for the member institutions of the Inter-University High Altitude Laboratory Association (Massachusetts Institute of Technology, University of Colorado, and University of Denver).

The NSF grant makes it possible for scientists of nonmember institutions to

use the facilities for a nominal charge. Inquiries should be addressed to Dr. Byron E. Cohn, Chairman, Department of Physics, University of Denver, Denver 10, Colo.

Those interested should note that the laboratory at Mount Evans is accessible from July through September. The Echo Lake laboratory provides living and research space throughout the year. Inquiries should be made at the earliest possible date.

College Faculty Salaries and Student Costs Both Rising, Government Study Shows

Average salaries for full-time faculty members in 4-year undergraduate colleges have risen 10.6 per cent during the past 2 years, to an average of \$6810 in the current academic year, the U.S. Office of Education recently announced. In 1957-58, the average was \$6160. In 1958-59, it was \$6490.

Figures for the 3 years are not precisely comparable because some colleges failed to answer the survey questions one or more times during that period. While approximately 1200 of the 1940 colleges and universities furnished information in 1957-58, more than 1400 responded in 1959-60. Institutions covered in the latest survey account for 91.1 percent of the enrollment in public institutions and 80.4 percent of the enrollment in private institutions.

For all institutions of higher education the rate of salary increase has averaged slightly less than 5 percent in each of the past 2 years. However, during this period increases have been greater (8.2 to 13.5 percent) in private institutions than in public ones.

The average salary in 4-year public institutions in the current academic year is \$7040, an increase of 8.8 percent over the \$6470 of 1957-58. The average salary in 4-year private institutions in the current year is \$6510, a 14.2-percent increase over the \$5700 of 1957-58.

In junior colleges and other 2-year institutions, the average salary for full-time faculty members is \$6110 in 1959-60, an increase of 7.6 percent over the 1957-58 figure of \$5680. In public 2-year institutions, the current average salary is \$6550, up 7.2 percent from the \$6120 of 1957-58. The figure for private 2-year institutions, \$4640

this year, is an increase of 14.6 percent over the \$4050 of 1957-58.

The study, which was conducted by W. Robert Bokelman, chief of the Business Administration Section of the Division of Higher Education, also shows a slow but perceptible increase in costs for full-time students in both public and private institutions of higher education. For example, resident students in private institutions paid an average tuition fee of \$615 in the current academic year, an increase of 16.9 percent over the 1957-58 average of \$526. Resident students in public institutions paid an average of \$168 this year as against \$155 in 1957-58.

Average charges for dormitory rooms for students is \$168 for men and \$174 for women in public institutions this year as against \$155 for men and \$160 for women in 1957-58. In private institutions, male students today are paying an average of \$201 and women students \$220 for dormitory rooms. In 1957-58 the figures were \$182 for men and \$194 for women.

Political Discrimination in Science Activities Opposed

Recently the governing board of the National Academy of Sciences-National Research Council issued the following "Resolution on Political Non-Discrimination in International Scientific Activities."

1) The Governing Board of the National Academy of Sciences-National Research Council desires that the United States maintain its intellectual and scientific leadership in international activities and emphasize and implement its role as a friendly host to international scientific meetings.

Meetings of international scientific bodies make a positive contribution to national security and welfare; they contribute to scientific progress in this country; they express the high value that the United States as a nation places on intellectual and scientific pursuits; they give scientists of other nations a first-hand opportunity to become acquainted with our scientific and cultural contributions to the welfare of all peoples.

2) The opportunity that an institution has to be a friendly host to an international scientific organization depends upon its ability to receive officers

and members of that organization and scientific delegates duly selected by the responsible participating scientific body in any country.

3) We endorse the spirit of the . . . statement approved in 1958 by the International Council of Scientific Unions, which (a) draws a distinction between the recognition of the activities of scientists and the political recognition of the government of the country or territory involved, and (b) affirms the right of the scientists of any country or territory to adhere to or to associate with international scientific activity without regard to race, religion, or political philosophy.

4) In view of the contribution of science to human welfare, we strongly believe that the foregoing considerations should be weighed in the formulation of governmental policy. We recognize that many other factors not primarily scientific must also enter into the formulation of this policy, but we urge that ingenuity and imagination be used to achieve the benefits of international cooperation in science.

Britain and U.S. Coordinate Time and Frequency Transmissions

The United Kingdom and the United States have begun coordination of their time and frequency transmissions to help provide a uniform system, which is needed in the solution of many scientific and technical problems in such fields as radio communications, geodesy, and the tracking of artificial satellites.

Participating in the project are the Royal Greenwich Observatory, the National Physical Laboratory, and the Post Office Engineering Department in the United Kingdom, and, in the United States, the U.S. Naval Observatory, the Naval Research Laboratory, and the National Bureau of Standards. This program is in line with previous cooperative efforts of these agencies to achieve uniformity and simplification in procedures.

The transmitting stations included in the coordination plan are GBR and MSF at Rugby, England; NBA, Canal Zone; WWV, Beltsville, Md.; and WWVH, Hawaii.

Coordination began in January. It is expected that by the end of 1960 the time signals from all the participating stations will be emitted in synchronism to the thousandth of a second.

In-Service Institute for High-School Teachers Announced

Opportunities for further study during out-of-school hours will be afforded about 9000 secondary school science and mathematics teachers in 1960-61 under the National Science Foundation's In-Service Institute Program. Grants to colleges and universities total about \$2.1 million and provide for 191 institutes in 44 states, the District of Columbia, and Puerto Rico.

These institutes are designed to improve science and mathematics instruction by enabling teachers to obtain additional knowledge of subject matter, including recent developments, in biology, chemistry, mathematics, physics, earth science, or general science. Institutes in radiation biology at Texas Woman's University and the University of Washington will be jointly sponsored by NSF and the Atomic Energy Commission.

Participating teachers receive 2 or 3 hours of instruction during each of the 30 weeks of the typical institute. They receive allowances for travel and books and pay no tuition or fees. Sponsoring institutions receive support for direct costs of operation.

The In-Service Institute Program began in the spring of 1957 with two institutes. To date the program has enabled more than 12,000 teachers in public and private secondary schools to increase their knowledge of science while continuing regular classroom duties. Participants are chosen by the sponsoring institutions, *not* by the National Science Foundation.

Consulting Group in High-Pressure Techniques Formed

Last October a meeting was held in Erie, Pa., under the auspices of Autoclave Engineers, Inc., to form a consulting group of scientists and engineers with experience in high-pressure techniques. One of the purposes of the group, to be known as High Pressure Associates, is to offer consulting services to any organization or individual in the general field of high pressure. Other objectives are the initiation of standards and the preparation of a handbook of safety measures.

For the present a relatively loose organization is being set up as a central clearing house. Those interested in making use of the service should write

to the chairman, Professor Barnett F. Dodge of Yale University, stating their problem. Dodge will put those who make inquiries in contact with whichever member of the Associates he believes most competent to give assistance.

Venezuelan Biological Station Invites Visitors from Abroad

The recently established Estación de Biología de los Llanos, in Calabozo, Venezuela, welcomes visits from research scientists abroad. The station occupies about 480 acres of pasture land on the edge of the central valley of the Orinoco River. It was established by the Sociedad Venezolana de Ciencias Naturales of Caracas, chiefly through private contributions. The new center can furnish laboratories and general facilities for field work and for preliminary work on the preparation and preservation of specimens.

In addition to the research that may be carried out at the station itself, which has a typical tropical lagoon and palm grove, interesting studies may be conducted in the area of the recently built Guarico Dam. There a new body of water, formed by the impounded Guarico River, has created conditions which provide an opportunity to observe changes in the plant and animal life of what was until recently a dry environment.

Only 5 hours by car or 1 hour by plane from Caracas, the Calabozo station offers excellent opportunities to the botanist, the zoologist, the ecologist, the pedologist, the geologist, and the physiologist to study the pasture lands of northern South America. Those who wish to conduct such tropical research will find that the station has comfortable lodgings. In addition to the station's facilities, visitors may make use of the facilities of the Universidad Central de Venezuela in Caracas, including the collections of the Instituto Botánico. For further information about the Estación de Biología de los Llanos, write by air mail to: Prof. A. Bonazzi, Correos del Este 4109, Caracas, Venezuela.

Survey of Water Use Planned

The Geological Survey plans to conduct an inventory of water use in the United States in 1960. Increasing demands for water are approaching the

limit of clean fresh water that is readily available at all times, although large quantities of water are still unused because they occur at the wrong times and places. To keep track of increasing demands, the Geological Survey is bringing up to date similar inventories made in 1950 and 1955. The inventory will be made by field personnel as part of their job of investigating the quantity and quality of the nation's water resources.

Information on water use will be compiled in six general categories: public supply; self-supplied industrial; steam-electric utility power plants; irrigation; rural domestic; and water power. These data will be tabulated by source—ground water or surface water.

Information on water use collected by municipalities, states, other federal agencies, associations of manufacturers, irrigation districts, and other organizations will be utilized in the study. Upon completion of the inventory, the Geological Survey will publish a report, probably by the end of 1962. Prelimi-

nary data will be available prior to that time.

The last previous report on this subject, *United States Geological Survey Circular No. 398*, stated that an average 240 billion gallons a day of water was withdrawn during 1955 for the nation as a whole, equivalent to about 1500 gallons per person.

Bradwell Nuclear Power Station Nears Completion

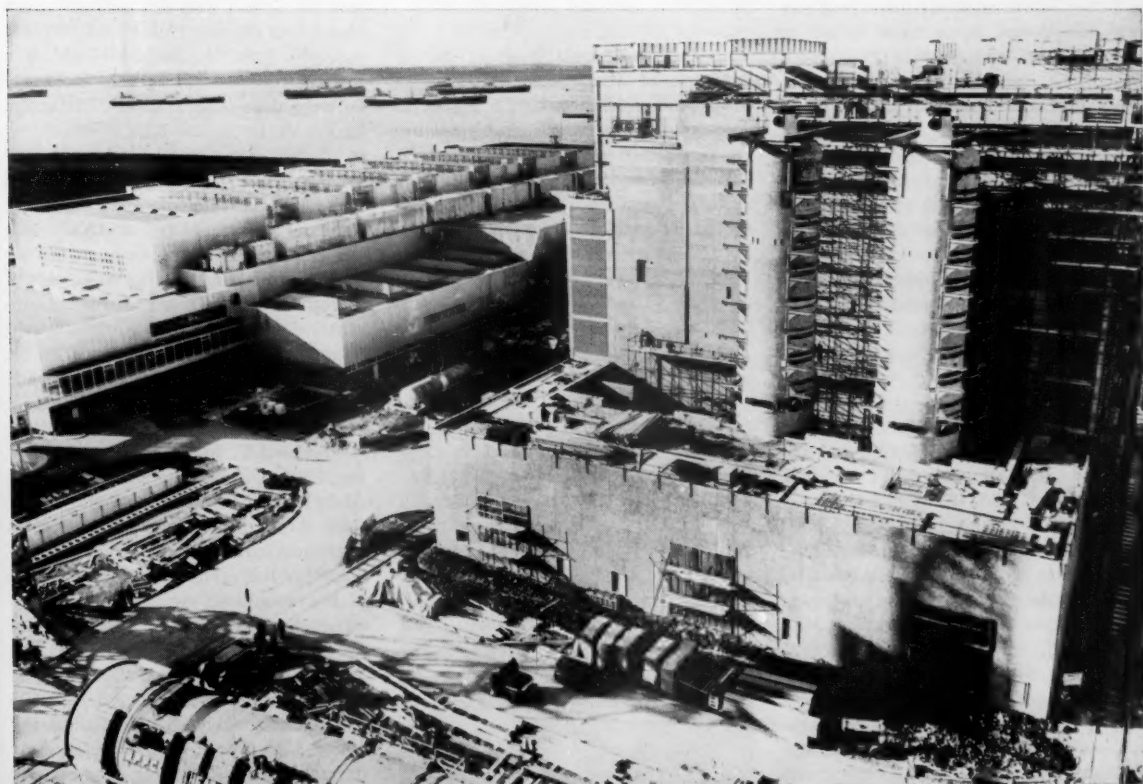
Bradwell Nuclear Power Station, which is being built in Essex, England, is one of more than a dozen such stations under construction or projected in Britain. Together they will give between 5000 and 6000 megawatts of electricity by 1966. Bradwell is scheduled to produce its first electricity this year. Its output when completed is expected to be 300 megawatts. The facility is a "descendant" of Calder Hall, the world's first station to produce power from nuclear energy on an industrial scale.

Britain Reports on Industrial Research

British manufacturing industry spent about £300 million on research and development in 1958, compared with about £190 million in 1955. This represents 4.2 percent of manufacturing industry's contribution to national production, as compared with 3.1 percent in 1955.

Ninety-five percent of the £300 million was spent in industry's own establishments, and about 5 percent on payment to outside bodies, such as cooperative research associations, universities, and other public and private research institutions. The main expenditures on research and development in 1958 were in aircraft (£100 million), electrical engineering (£64 million), and chemicals (£43 million).

These estimates are contained in a Department of Scientific and Industrial Research survey, *Industrial Research and Development Expenditure 1958*, published this month. The first report, that for 1955, was published in 1958.



Bradwell Nuclear Power Station, Essex, England. The last of 12 heat exchangers, still under construction, is partly visible in the left foreground. On the right, two of the exchangers are already in position. [British Information Service]

News Briefs

Soviet telescope. The Soviet Union is planning to build an optical telescope bigger than the 200-inch telescope at Mount Palomar, Calif., now the world's largest. It is reported that the new instrument will be a reflector in which the light will be gathered by a mirror having a diameter of almost 20 feet. Design work has begun at the Pulkovo Observatory, chief center of Soviet astronomical research. No date for completion of the instrument has been announced.

* * *

State radiation control. The Atomic Energy Commission has transmitted to the state governors a set of proposed criteria by which the commission may relinquish to the states control of certain radioactive materials.

* * *

New medical school considered. Nelson Rockefeller, governor of New York, has announced the creation of a special county commission that will study the need for a medical college in Nassau County.

* * *

U.S.-Chilean antarctic research. Chile and the United States have agreed to cooperate in a scientific program in Antarctica in order to continue the work that was started during the International Geophysical Year. The United States is making available a vessel suitable for scientific investigation, and Chile, on its part, has agreed to provide the operational and administrative supplies and services needed for operation of the vessel. Scientists from both countries will participate in research programs aboard the vessel, and scientists from other countries may also be invited to participate.

* * *

Sociology congress. The 19th Congrès International de Sociologie will be held in Mexico City, 31 August-6 September. This is the first time this congress has been held on the American continent. In recognition of the event, the subject this year will be "Thèmes de Sociologie Latino-Américaine." Carle C. Zimmerman, 200 Emerson Hall, Harvard University, Cambridge 38, Mass., is secretary for the United States and Canada.

* * *

Youth program. A grant from the National Cancer Institute has been awarded to the National Science Teachers Association (Washington, D.C.) in

support of a new youth program, "Vistas in Science." "Vistas in Science" is planned as a series of booklets which will foster student interest in research techniques, scientific investigations at the secondary school level, and careers in science: "Vistas in Science" is the first activity of NSTA's Future Scientists of America, a program which will provide services and materials for science teachers and students.

Scientists in the News

Karl F. Meyer, a specialist in diseases of wild animals transmissible to man, has been named the recipient of the 1960 Howard Taylor Ricketts Memorial Award of the University of Chicago. Meyer is director emeritus of the George Williams Hooper Foundation for Medical Research of the University of California and professor emeritus of experimental pathology. He will visit the University of Chicago on 6 June to accept the award and to deliver the annual Ricketts Lecture. He will speak on "Plague in the Light of Newer Knowledge" at 5 P.M. in Billings Hospital.

R. Gaurth Hansen, head of the department of agricultural chemistry at Michigan State University, received the \$1000 Borden Award in nutrition during the recent annual meeting of the American Institute of Nutrition in Chicago. He was honored for his research in lactose metabolism.



R. Gaurth Hansen

Reuben G. Gustavson, professor of chemistry at the University of Arizona, was honored at a dinner in Chicago during the recent annual meeting of the Federation of American Societies for Experimental Biology. Karl Dittmer of the American Chemical Society in Washington was master of ceremonies at the tribute dinner. During the evening it was announced that a Reuben G. Gustavson Lectures in Science Fund is being established at Denver University by Gustavson's friends.

Gustavson, a native of Denver, was a member of the faculty of Denver University, then president of the University of Colorado during the war years, vice president of the University of Chicago, chancellor of the University of Nebraska, and the first director of the Ford Foundation's Resources for the Future, Inc.

David Finkelstein, Stevens Institute of Technology physicist who conceived and developed the Megatron, has been named Young Men's Philanthropic League professor of physics at the Graduate School of Mathematical Sciences of Yeshiva University. He will join the school next fall and will teach theoretical physics. During the 1960-61 academic year, he will continue as a visiting professor at Stevens, to carry forward development of the Megatron.

The following men have been named recipients of the Department of Defense Distinguished Civilian Service Award, highest honor conferred on DOD civilian employees.

Wilber S. Hinman, Jr., technical director, Diamond Ordnance Fuze Laboratory, Department of the Army, Washington, for his leadership and for his scientific contributions, especially in the use of radiosonde for weather forecasting.

Eberhard F. M. Rees, deputy director, Development Operations Division, Army Ballistic Missiles Agency, Redstone Arsenal, Huntsville, Ala., for his contributions to such major accomplishments as the first successful launching of heavy ballistic missiles of long and intermediate range, the launching of the first United States earth satellite, and other major missile developments.

Harry Hoogstraal, head, department of medical zoology, Naval Medical Research Unit No. 3, Cairo, United Arab Republic, for his research on ticks and the tick-borne diseases of man and animals.

Gordon O. Pehrson, director, Plans and Programs Division, Special Projects Office, Naval Bureau of Ordnance, Washington, for his contributions to the fleet ballistic missile program.

Paul C. Tompkins, scientific director, Naval Radiological Defense Laboratory, San Francisco, for his contributions to the field of nuclear research.

Albert P. Crary, supervising physicist, Cambridge Research Center, Bedford, Mass., for his research in polar areas.

The following scientists from South Africa are visiting the United States.

R. H. Ford, principal technical officer, South African Bureau of Standards, Council for Scientific and Industrial Research, Pretoria, will be here until 4 June to see work in microbiology, entomology (insecticides), and mycology (fungicides). His itinerary includes New York, Stamford (Conn.), Princeton, Keyport (N.J.), Wilmington (Del.), Washington, Beltsville (Md.), Baltimore, and Chicago.

F. G. Holliman, professor, University of Cape Town, will be here until mid-July to visit laboratories engaged in bacteriological chemistry. His itinerary includes New York, Boston, Washington, and Peoria (Ill.).

P. G. Odendaal, of the Physico-Chemical Analysis Laboratory, South African Bureau of Standards, Council for Scientific and Industrial Research, Pretoria, will be here until 8 June to visit laboratories engaged in spectrographic analyses, spectrophotometric analyses, x-ray diffraction, polarography, and gas chromatography. His itinerary includes Washington, Baltimore, Wilmington (Del.), St. Louis, Detroit, Cleveland, Pittsburgh, Rochester (N.Y.), and Linden (N.J.).

J. R. Gaillard, chief chemist of the City of Durban, Union of South Africa, will be here until 31 May to study developments in sewage disposal. His itinerary includes New York, Miami, Pittsburgh, Columbus, Chicago, Toledo, Niagara Falls, and Montreal.

T. W. Steele of the Analytical Section, Government Metallurgical Laboratory, University of Witwatersrand, Johannesburg, will be here until 5 June to study analytical methods employed in uranium refining processes. His tour is being arranged through the Atomic Energy Commission, and his itinerary includes New Brunswick (N.J.), Washington, Ames (Iowa), and Weldon Springs (Mo.).

A. M. Mehl of the Mechanical, Civil

Engineering and Packaging Department, South African Bureau of Standards, CSIR, Pretoria, will be here until 11 June to study the operation and control of standardization bodies and laboratories. His itinerary includes Washington, New York, Pittsburgh, Madison (Wis.), and Chicago.

A. J. A. Roux, research director, Atomic Energy Board, South Africa, accompanied by **J. R. Colley** and **Mr. Sandrock** of the Atomic Energy Board, will be here until 11 June to tour Atomic Energy Commission installations. The group's itinerary includes New York, Oak Ridge, Chicago, and Washington.

Chauncey D. Leake, AAAS president and assistant dean of the College of Medicine at Ohio State University, will be the principal speaker at Antioch College's commencement on 18 June.

Paul F. Kerr, Newberry professor of mineralogy at Columbia University, was awarded an honorary degree by Occidental College in Los Angeles, Calif., on 24 March.

Peter H. Rossi has been named director of the National Opinion Research Center of the University of Chicago. He will succeed **Clyde W. Hart**, who is retiring on 30 June after 13 years as director of the center. Rossi, who will retain his academic position as an associate professor of sociology at Chicago, has been a research consultant and a senior study director of the Research Center. He is known for his studies of political behavior, community organization, and the sociology of education.

T. P. Nash, Jr., dean of the School of Biological Sciences of the University of Tennessee, will retire this summer. Nash has served as dean since 1928. **Roland H. Alden**, professor and chief of the division of anatomy, will serve as acting dean of the school.

Carl F. Miller, supervisory physical science administrator, has been promoted to head the Nucleonics Division in the U.S. Naval Radiological Defense Laboratory in San Francisco. Prior to assuming his new position, Miller was head of the Technical Developments Branch of the laboratory, directing contamination-decontamination tests in which simulated fallout is used on different types of surfaces.

William B. Wiegand of New York, research consultant in rubber chemistry and former vice-president and director of research for the Columbian Carbon Company, has won the American Chemical Society's Charles Goodyear Medal, highest honor in rubber chemistry. The Rubber Chemistry Division of the Society presented the award in recognition of Wiegand's research on the reinforcement of rubber by carbon black.

William M. Schmidt has been appointed professor and head of the department of maternal and child health of the Harvard School of Public Health. He succeeds **Martha May Eliot**, who will retire on 1 July to become professor emeritus of maternal and child health. With the exception of a period when he served as medical advisor to the American Joint Distribution Committee, Schmidt has been a member of the public health faculty at Harvard since 1949.

Sarah Ratner of the Public Health Research Institute of the City of New York has received the Carl Neuberg Medal of the American Society of European Chemists for her outstanding contributions in the field of nitrogen metabolism.

Recent Deaths

Avila Bedard, Quebec, Canada; 75; deputy minister of lands and forests since 1937; author of a number of books and essays on forest management and conservation; 2 May.

John S. O. Herrlin, Jr., Douglaston, N.Y.; 62; professor of clinical surgery at the New York Medical College; 1 May.

Conrad Limbaugh, Port Mion, France; 35; chief diving officer at Scripps Institution of Oceanography, University of California, La Jolla; 20 Mar.

August W. Raspet, Starkville, Miss.; 46; founder and director of the aerophysics department at Mississippi State University; 27 Apr.

Wendell Reeder, Dallas, Tex.; 49; physiological chemist; president of Campbell Taggart Research Corp. and research director for Campbell Taggart Associated Bakeries, Inc.; an authority on cereal chemistry, he was a leader in promoting and testing new varieties of wheat; 10 Apr.

Book Reviews

Social Change in Tikopia. Re-study of a Polynesian community after a generation. Raymond Firth. Macmillan, New York, 1960. 360 pp. Illus.

The tiny Pacific island of Tikopia is already well known to anthropologists, thanks to Raymond Firth, who studied this isolated Polynesian community in 1929 and whose books, *We, the Tikopia* (1936), *A Primitive Polynesian Economy* (1939), and *Work of the Gods in Tikopia* (1940), are models of the highest standards in ethnographic reporting. *Social Change in Tikopia* represents a restudy of the island undertaken in 1952 with the assistance of James Spillius. It is a record of social change in Tikopia and, at the same time, of Firth's own growth as one of the leading anthropologists of our time. His account of political organization and social control, for example, is as sophisticated for the present as was his account of economic organization for two decades ago.

The book is more than a study of social change in other respects, also. Just before Firth's arrival in 1952 a serious hurricane had swept the island and destroyed most of its food resources. Firth provides an unusual account of the society's response to sudden crisis and of its operation during a famine. Rarely do anthropologists have such an opportunity to study isolated and economically self-sufficient communities trying to cope with disaster, largely through their own efforts and cultural resources; it is especially rare when such a study can be made of a community whose operation under normal circumstances has already been recorded.

Firth reviews in detail changes in economic outlook which have resulted from increased outside contact and population growth. Of interest is his analysis of how money has come to fit into the native economy. From economic change, he proceeds to a discussion of

changes in land rights and calls attention to the greater individualization of holdings; this is not a result of Western influence, as might be supposed, but a response to internal pressures on subsistence resulting from the abandonment of traditional practices of population control. Analyses of patterns of residence and marriage, the system of lineages and clans, the political structure, and the system of social control are also presented in detail with an assessment of the amount and nature of change in each. Religious changes are not included in this volume.

Two things characteristic of Firth's work give this study special value. One is his sense of history and his view of ethnography as a form of historiography, which leads him to present detailed accounts of events as he observed them. The reader is brought directly to the scene and given ample opportunity to see Tikopia in action. The other feature of note is Firth's excellent use of his concept, developed between the two visits to Tikopia, of *social organization* as distinct from *social structure*. He concludes that Tikopian social structure has changed little, but that there have been a number of organizational changes within the structural framework which, if they persist, must soon lead to structural changes as well. Whatever the limitations of this conceptual distinction may be, it helps Firth avoid the trap into which some students of change have fallen. Firth does not confuse behavioral change with cultural change, nor does he interpret different applications of a people's principles of social action to changing conditions as if the different applications represented changes in the principles themselves.

The final conclusion deserves quotation: "What the example of Tikopia shows is that even in a very small-scale society such as this, processes of social change are complex. There is no simple determinism. The changing

forces of the environment and forces of production, including the changing structure of the technological system, have clearly been of great importance. But so also have been the forces involved in the system of social allocation. All of these have operated, together with conceptual and decisional elements of individual and group behavior, in a field where alternatives for choice have always been possible. The existence of such alternatives, including those between material and symbolic satisfactions, renders it impossible for any social analysis to predict more than in a very tentative way the future history of a society" (pages 353-54).

Because he has attended to detail and has been faithful to his role as historian as well as analyst, Firth has written a book which thoroughly documents this conclusion.

WARD H. GOODENOUGH
*Department of Anthropology,
University of Pennsylvania*

Artificial Earth Satellites. vols. 1 and 2. L. V. Kurnosova, Ed. Translated from the Russian. Plenum Press, New York; Chapman and Hall, London, 1960. 107 pp. \$9.50.

The Soviet Academy of Sciences is to be commended for publishing a series of volumes which will carry all of the Russian papers dealing with problems of satellites and space research. Three volumes have already appeared; the first two have been translated by the Plenum Press and are published in the present book. The articles cover a broad range of scientific subjects and contain experimental results and theories, in many cases preliminary, from the first three sputniks. Since the third volume contains the results obtained from lunik, the title *Artificial Earth Satellites* is somewhat misleading. The editor of the series, L. V. Kurnosova, is an important contributor to the Soviet scientific effort in space investigations; her specialty is in the field of cosmic rays. The translation is excellent as far as I can judge, and the graphs are quite excellent.

The series of papers opens with a contribution by S. N. Vernov and his colleagues on the measurements of cosmic rays made by Sputnik II. I found figure 1 of particular historical interest. It is titled "The altitude dependence of the cosmic ray intensity," but it shows very clearly a rise in intensity starting

at about 400 km and increasing by about 50 percent at the highest point, 700 km. As is now well known, the increase is produced not by cosmic rays but by particles of lower energy trapped in the earth's magnetic field. However, the Russians were limited to data obtained by telemetering over the Asian continent and did not receive results from the apogee of the satellite. In contrast, data sent back by our Explorer I satellite were obtained at an altitude high enough to make the increase quite clear-cut, and thus the presence of something different from the normal cosmic radiation was definitely indicated. In volume 2, based on results obtained with Sputnik III, both Krassovsky and Vernov show that they are aware of trapped radiation.

Other papers deal with the determination of upper atmosphere densities, satellite orbits, radio and optical observations of satellites, and the interaction of satellites with the ionosphere. Of particular interest are the ionospheric studies, reported by Krassovsky, indicating the very high electron densities in the upper region of the ionosphere which had not been previously accessible to direct measurements. The Soviet measurements on the electric charge of satellites are still unique and have not been repeated elsewhere.

After this successful beginning, one may look forward with anticipation to the translation of further volumes as they appear.

S. F. SINGER

Physics Department,
University of Maryland

Lewis Henry Morgan, American Scholar. Carl Resek. University of Chicago Press, Chicago, Ill., 1960. xi + 184 pp. Illus. \$4.50.

This is a timely biography. Evolutionism in anthropology is being rehabilitated, and with this major reversal in perspective, it becomes necessary to rewrite the intellectual history of the discipline. In earlier decades of this century Morgan, along with the other 19th-century evolutionist pioneers, was first stoned outright by Western scholars and then buried under an avalanche of indifference. But now his books are being reissued, his journals are being edited, and publishers apparently find that he "sells." Resek makes the point that the waxing and waning of Morgan's

influence may well reflect turns in American thought and life. Compared with Bernhard Stern's 1931 biography (*Lewis Henry Morgan, Social Evolutionist*), Resek's more sympathetic treatment is good documentation for this point.

Morgan, in the words of a contemporary, charted "a new continent of scholarship." In *The League of the Iroquois* (1851) he produced anthropology's first work in scientific ethnography. He entered comparative ethnology through a systematic study of kinship in the belief that he could demonstrate thereby the Asiatic origin of the American Indian. He emerged from this study, in his famous *Ancient Society* (1877), with a grand theory of the evolution of culture based on the evolution of technology, a theory that linked the development of the state to the development of private property. As a man and a scholar—as Resek says and then richly describes in fine style—Morgan cannot be easily categorized. Besides being an anthropologist, he was a lawyer, a politician, an entrepreneur, president of the American Association for the Advancement of Science, defender of the Indian, a true believer in the American Republic, and the author of a definitive treatise on the American beaver. It was left to history to display, in a huge paradox, Morgan's kaleidoscopic variety: after Marx and Engels discovered his writing, this upstate New York, Republican bourgeois was posthumously elevated to the status of a socialist prophet.

Yet Resek does not in any way convey the view that Morgan was an inconsistent, erratic thinker. One of the values of this book is that it is an antidote to Stern's volume. In Stern's hands, Morgan, caught in a crossfire of Marxism and Boasian antievolutionism, suffers the worst of both worlds and emerges as a virtual class enemy, as well as a "not erudite," unoriginal thinker with a few good ideas and more bad ones. Resek, an intellectual historian, does not consider Morgan's anthropological ideas as fully as Stern did, although Resek's discussion of classificatory kinship terminology, which Stern misunderstood, indicates that this might have been profitable. But Resek, in telling how Morgan's ideas developed, is much more convincing than Stern. And, in describing Morgan's development, he corrects Stern's assertions about Morgan's religious fundamentalism, the relation of Morgan's ideas to

Darwinism, his attitude toward democracy, property, and American expansion, his originality as an intellect, and a number of other matters, large and small, ranging down to the adequacy of his library. Resek considers it the task of the intellectual historian to "uncover the assumptions that men live by in another time and place and that they modify or exchange for others as experience demands . . ." I think he has done this well for Morgan. He seems to give truth to a prophecy written by Francis Parkman in a letter to Morgan: "The more advanced we become in intellectual progress, the more your labors will be appreciated."

MARSHALL D. SAHLINS
Department of Anthropology,
University of Michigan

Advances in Organic Chemistry. Methods and Results. vol. 1. Ralph A. Raphael, Edward C. Taylor, and Hans Wynberg, Eds. Interscience, New York, 1960. x + 387 pp. Illus. \$12.

This volume contains six chapters: (i) "The Kolbe electrolytic synthesis," B. C. L. Weedon (34 pages); (ii) "Polysulfonic acid as a reagent in organic chemistry," F. Uhlig and H. R. Snyder (47 pages); (iii) "The Wittig reaction," S. Trippett (20 pages); (iv) "Hydroxylation methods," F. D. Gunstone (45 pages); (v) "The selective degradation of proteins," E. O. P. Thompson (90 pages); and (vi) "Optical rotatory dispersion and the study of organic structures," W. Klyne (110 pages). An author index (26 pages) and a general subject index (13 pages) are provided. Each chapter is well written, by an authority on the subject, and each is an adequate, up-to-date account of the practical aspects of the topic, together with relevant theory, helpful experimental details, and results obtained. The book is well bound, beautifully printed and illustrated, and (considering the wealth of information it contains) woefully underpriced.

Despite these merits, some doubt might be entertained concerning any real need for this volume (and, by extension, the projected series), since four of the topics covered have been the subjects of excellent theoretical reviews within the past two years [Chapter 2, *Chemical Reviews* 58, 321 (1958); 3, *Angewandte Chemie* 71, 260 (1959); 5, *Progress in Organic Chemistry*, vol.

4 (Academic Press, New York, 1958); and 6, C. Djerassi, *Optical Rotatory Dispersion: Applications to Organic Chemistry* (McGraw-Hill, New York, 1960)]. Nevertheless, because of its practical approach, the book does fill a need, particularly for research chemists. Perhaps, to be sure of securing a permanent niche for this series, the editors should, in the future, defer treating any topic recently reviewed elsewhere from a similar point of view, unless the new chapter is far superior to its predecessor or records special progress in the field.

R. STUART TIPSON

Division of Chemistry,
National Bureau of Standards

Plant Physiology. A treatise. vol. 2, *Plants in Relation to Water and Solutes*. F. C. Steward, Ed. Academic Press, New York, 1959. xvii + 758 pp. Illus. \$22.

Progress in plant physiology is well documented by an annual review, a number of recent textbooks, several treatments of plant biochemistry, and a multivolume *Handbook*. The appearance of another projected, six-volume treatise marks the zeal of F. C. Steward, the editor, and invites comparison.

The time has surely passed for the exhaustive treatment of a subject by one man. But one man can try to inspire a small group to accomplish a unified treatment and, by exercising adequate diligence as an editor, hope to impart the scholarship that the subject merits. This first volume, volume 2 of the series, indicates that these hopes are realized.

The headings and authors of the seven chapters on the functioning of water in plants are: (i) "Cell membranes, their resistance to penetration and their capacity for transport," by R. Collander; (ii) "Water relations of cells," by T. A. Bennett-Clark; (iii) "The water relations to stomatal cells and the mechanisms of stomatal movement," by O. V. S. Heath; (iv) "Plants in relation to inorganic salts," by F. C. Steward and J. F. Sutcliffe; (v) "Translocation of organic solutes," by C. A. Swanson; (vi) "Translocation of inorganic solutes," by O. Biddulph; and (vii) "Transpiration and the water economy of plants," by P. J. Kramer. These chapters cover all aspects of the subject from the pertinent properties of the individual

cell to the functioning of the organized plant.

Concepts about the behavior of water in plants have gradually developed during the last century and are fairly definite. These classical concepts are summarized in a descriptive way with adequate literature references to guide new students. Each chapter is thorough, and several are exciting for the depth of insight given into the development of concepts.

In criticism, mathematical treatments are studiously avoided. This is surprising for a subject that is fundamentally mathematical in content. As a result, rates of processes are largely ignored; only one differential equation is used in the 758 pages. Free-energy relationships and other thermodynamic aspects are mentioned only in a minor vein. An air of mysticism sometimes enters; for example, "Thus the investigator must still stand, awed but challenged, by that built in capacity for growth . . . which exists in the fertilized egg and which, through the beautifully coordinated and balanced process of organic and inorganic nutrition maintains the internal composition of the environment. By the accumulation and diversification of substance in plants, one can describe their growth: It is equally true . . . that the driving force which permits . . . accumulation of salts from the very dilute external solutions and which distributes and stores them in selected regions of the plant body is incomprehensible without the ability to grow." What is food to one may be fierce poison to others.

S. B. HENDRICKS

Mineral Nutrition Laboratory,
U.S. Agricultural Research Service

The Scientific Papers of Sir Geoffrey Ingram Taylor. vol. 2, *Meteorology, Oceanography and Turbulent Flow*. G. K. Batchelor, Ed. Cambridge University Press, New York, 1960. x + 515 pp. Illus. \$14.50.

This second volume of Sir Geoffrey Taylor's *Scientific Papers* is the first of three volumes that will be devoted to Taylor's work on the mechanics of fluids. It contains 45 papers on meteorology, oceanography, and turbulent flow. The phenomenon of turbulence and its effects provides the main theme of this volume, but many geophysical investigations are also covered.

New Books

Biological and Medical Sciences

Braungart, Dale C., and Rita Buddeke. *An Introduction to Animal Biology*. Mosby, St. Louis, ed. 5, 1960. 416 pp. \$6.25.

Christophers, S. Rickard. *Aedes Aegypti* [L.]. *The Yellow Fever Mosquito*. Its life history, bionomics and structure. Cambridge Univ. Press, New York, 1960. 751 pp. \$14.50.

Falconer, D. S. *Introduction to Quantitative Genetics*. Ronald, New York, 1960. 374 pp. \$6.

Jayle, Gaetan E., Albert G. Ourgaud, L. F. Baisinger, William J. Holmes. *Night Vision*. Thomas, Springfield, Ill., 1959 (translated from *La Vision Nocturne et Troubles*, Masson, Paris, 1950). 422 pp. \$13.50. In an introduction to the English edition, Sir Stewart Duke-Elder writes "One of the most outstanding monographs which has appeared since the World War. . . . This monograph is much more than the usual review . . . provides a critical assessment and integrative judgment on a multitude of incompatible theories. . . ."

Zakhvatkin, A. A. *Fauna of the U.S.S.R. Arachnoidea*. vol. 6, No. 1, *Turoglyphoidea Acari*. Translated and edited by A. Ratcliffe and A. M. Hughes. American Inst. of Biological Sciences, Washington, D.C., 1959. 578 pp. \$10.

Economics and the Social Sciences

Birket-Smith, Kaj. *The Eskimos*. Translation of 1959 rev. ed. by W. E. Calvert. Methuen, London; Humanities Press, New York, 1960. 277 pp.

de Huszar, George B., Ed. *The Intellectuals*. A controversial portrait. Free Press, Glencoe, Ill., 1960. 551 pp. \$7.50.

Hognin, H. Ian. *Social Change*. Watts, London; Humanities Press, New York, 1960. 257 pp.

Katona, George. *The Powerful Consumer*. Psychological studies of the American economy. McGraw-Hill, New York, 1960. 285 pp. \$6.50.

Lange, Charles H. *Cochiti*. A New Mexico pueblo, past and present. Univ. of Texas Press, Austin, 1960. 644 pp. \$10.

Lennard, Henry L., and Arnold Bernstein. *The Anatomy of Psychotherapy*. Systems of communication and expectation. Columbia Univ. Press, New York, 1960. 229 pp. \$6.

Spitz, René A. *A Genetic Field Theory of Ego Formation*. Its implication for pathology. International Universities Press, New York, 1959. 123 pp. \$3.

Stein, Maurice R., Arthur J. Vidich, David Manning White. *Identity and Anxiety*. Survival of the person in mass society. Free Press, Glencoe, Ill., 1960. 658 pp. \$7.50.

Wedel, Waldo R. *An Introduction to Kansas Archeology*. With "Description of the skeletal remains from Doniphan and Scott counties, Kansas" by T. D. Stewart. Smithsonian Institution, Washington 25, 1960 (order from Supt. of Documents, GPO, Washington 25). 740 pp. \$3.

Reports

Form of the Pubic Bone in Neanderthal Man

Abstract. Shanidar I and III from Iraq have the same peculiar form of pubis as Tabūn I from Palestine. These are the only such pubes known to exist. These facts suggest that Neanderthal man (Shanidar-Tabūn) and an early variety of modern man (Skhūl) coexisted during Mousterian times in this part of the world.

In 1939 Theodore D. McCown, now of the University of California, Berkeley, and the late Sir Arthur Keith of the Royal College of Surgeons, England, published an elaborate description (1) of a series of ancient human skeletons from two caves—es Skhūl and et Tabūn—at Mount Carmel, Palestine. In a preceding volume (2) the British archeologists, Dorothy Garrod and Dorothy Bate, had represented the stone industry associated with the skeletons as of the Levallois-Mousterian period of the Old Stone Age. This, together with the associated fauna, points to a late Pleistocene age, and specifically to the early Würm stage of the Last Pluvial (3).

Until the completion of the study by McCown and Keith it had been more or less expected that the Mount Carmel skeletons would show the rather uniform physical characteristics exhibited by the Mousterian or Neanderthal men known up to that time. On the contrary, only the Tabūn remains are like the classic Neanderthals of Europe, the Skhūl remains being in many ways remarkably similar to modern or Neanthropic man.

Although these differences are best exemplified in the skulls, they extend

to other skeletal parts, including the pelvis. In the latter connection, one statement by McCown and Keith (1, pp. 71-72) is not generally appreciated: "... the anatomical details [of all the specimens from the Skhūl cave] agree with those found in the pelvis of Neanthropic man, particularly the Cro-magnon pelvis, rather than with those of the pelvis of Neanderthal man. Yet in total assemblage of characters we meet with a larger proportion of Neanderthal features than are met with in any modern race of Neanthropic man... but the woman (Tabūn I) from the Tabūn cave presents an altogether peculiar pelvic picture. Her pelvis differs not only from those of the Skhūl people but presents features, particularly in the conformation of her pubic bones, which have not been met before, either in living or in fossil man... We cannot think that her pelvic features are merely a manifestation of individual variation; they seem too sharply defined for that. The pelvic features force upon us a need for hesitation in regarding this remarkable woman from the Tabūn cave as a mere variant of the Skhūl type."

These contrasting pelvic features, as illustrated by McCown and Keith, are shown in Figs. 1 and 2. Note in the Tabūn innominate the delicate, plate-like form of the superior ramus of the pubis, and compare it with the stout, rounded form of the same part in the Skhūl innominates. Note also the much greater size of the obturator foramen in the Tabūn specimen. On the basis of these illustrations probably all students of the human skeleton will agree that the Skhūl pelvis are essentially modern in character, and on the other hand that the forepart of the Tabūn specimen cannot be duplicated in modern man.

McCown and Keith wisely refrained from drawing conclusions from these pelvic features, because the more primitive Tabūn group was represented by a single pelvis and because the form of the pubic bone in Neanderthal man was unknown outside the Mount Carmel specimens. Obviously more specimens were needed to show whether such a fundamental difference existed beyond the Tabūn woman.

The picture is now clarified as a result of work on skeletons I and III recovered in 1957 in the upper part of the Mousterian layer at Shanidar, a cave site in northern Iraq about 600 miles in a direct line northeast of Mount Carmel (4). These skeletons have been shown by the carbon-14 dating method to have an age around 50,000 years, which places them in the final part of Würm I or more probably in the Würm I-II interstadial (5). This would make the Shanidar skeletons somewhat younger than the Mount Carmel skeletons. In a preliminary report on the skull of Shanidar I (6), I called attention to its many primitive features and related them to Tabūn rather than to Skhūl. Altogether surprising is the persistence of this kind of Neanderthal to such a late date.

Among the restorable parts of the skeleton of Shanidar I is a pair of pubic bones. The left bone, shown in Fig. 2, obviously has the same peculiar features as that of Tabūn I. Since Shanidar I appears to be a male, these pelvic features are not sex-induced changes.

Shanidar III, which was brought to Washington for study, is represented by a few fragments, including part of the right pubis (Fig. 3). This pubic fragment includes only the median portion of the superior ramus, but enough to show much the same flat structure as the corresponding part of Tabūn I and Shanidar I. Judging from size, Shanidar III is probably male.

By putting together the facts set forth here, it is now possible to say that the Tabūn and Shanidar specimens combine a virtually classic Neanderthal skull morphology with a

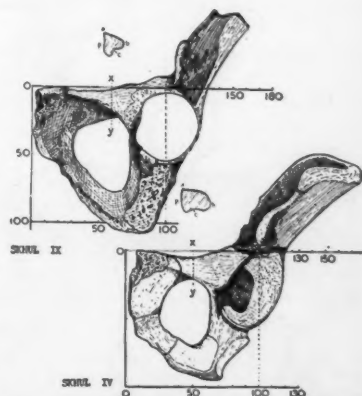


Fig. 1. Two Skhūl innominate bones (left) with cross sections of the superior pubic rami along the lines x-y: a, linea arcuata; b, ventral margin; p, pelvic aspect; c, groove for the obturator nerve. [Modified from McCown and Keith (1, Figs. 49c, 49f, 50, and 52)]

Instructions for preparing reports: Begin the report with an abstract of from 45 to 55 words. The abstract should not repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to one 2-column figure (that is, a figure whose width equals two columns of text) or to one 2-column table or to two 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [Science 125, 16 (1957)].

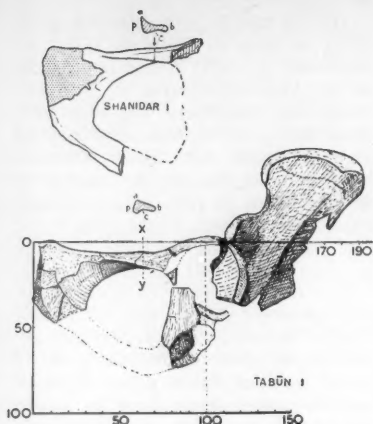


Fig. 2. Left pubic bone of Shanidar I and left innominate bone of Tabun I, each with a cross section of the superior pubic ramus along the line x-y. Explanation of abbreviations in Fig. 1. [Lower figure modified from McCown and Keith (1, Figs. 49g and 53)]

unique shape of pelvis, whereas the Skhul specimens combine a nearly modern skull morphology with an essentially modern shape of pelvis. The pelvic differences impress me as having as much significance as the skull differences. Together they amount to a fundamental difference.

So long as the skulls from Mount Carmel were mainly the subject of discussion, interpretations of their variations took two courses: (i) "the

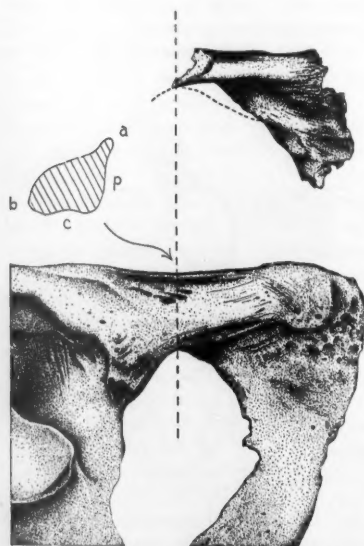


Fig. 3. Fragment of right pubic bone of Shanidar III shown in comparison with the corresponding part of a modern specimen (male). Explanation of abbreviations in Fig. 1.

Mount Carmel people were in the throes of evolutionary change" (1, p. 14), or (ii) "the Mount Carmel population arose . . . as a result of hybridization of a Neanderthaloid and a modern type, these types having been formed earlier in different geographical regions" (7, p. 258). In view of the new evidence, neither of these explanations seems completely logical. To my way of thinking it is simpler and more reasonable to strip the Mount Carmel remains of the role of a "population," and especially a hybrid population, and to recognize their two components as fundamentally distinct. There is no reason now to regard the Skhul specimens as anything other than representatives of an early variety of modern man. The Tabun-Shanidar specimens then become representatives of the local Neanderthal variety, which probably went on to extinction. All this does away with the need for setting up hypothetical types and for assuming that the whole lot of the Mount Carmel skeletons represents a single breeding population.

It may be objected that spatial separation is required to maintain the distinctiveness of human varieties and that the Mount Carmel caves did not afford such separation. In general this is a valid objection, but as yet there is no proof that the recovery of two different varieties of man from a cultural layer which accumulated over thousands of years in the Mount Carmel caves necessarily means actual physical contact between these varieties. I have stated elsewhere (8) my reasons for doubting that the Skhul and Tabun remains represent a breeding population. The fact that these remains were separated stratigraphically most likely means that the distinct varieties which they represent were separated in space; in other words, separate occupation of the caves at different times by these distinct human varieties could have taken place while they were living in the surrounding area as breeding isolates. The concept of contemporary breeding isolates is well established, but the nature of the isolates in this instance cannot be clearly discerned. Incidentally, such an explanation often has been precluded in the past by the dubious assumption that all remains of ancient man have to be fitted into a straight evolutionary line.

To recapitulate, then; the evidence here presented forces consideration of the possibility that an early variety of modern man lived side by side, so to speak, with a Neanderthal variety during Mousterian times in the area now designated as the Near East.

T. D. STEWART

U.S. National Museum, Smithsonian Institution, Washington, D.C.

References and Notes

1. T. D. McCown and A. Keith in *The Stone Age of Mount Carmel* (Oxford Univ. Press, London, 1939), vol. 2.
2. D. A. E. Garrod and D. M. A. Bate in *The Stone Age of Mount Carmel* (Oxford Univ. Press, London, 1937), vol. 1.
3. F. Clark Howell, *Quart. Rev. Biol.* **32**, 338 (1957); *Proc. Am. Philos. Soc.* **103**, table 10, (1959).
4. R. S. Solecki, *Sci. Am.* **197**, 59 (1957).
5. —, personal communication.
6. T. D. Stewart, *Sumer* **14**, 90 (1958); reprinted in *Smithsonian Inst. Ann. Rept.* 1958 (1959), p. 473.
7. T. Dobzhansky, *Am. J. Phys. Anthropol.* **2**, 251 (1944).
8. T. D. Stewart, *Cold Spring Harbor Symposia Quant. Biol.* **15**, 97 (1951).

22 January 1960

Fusion of Complex Flicker II

Abstract. Flicker waveform has been found to have a slight but specific effect upon fusion threshold. A depression of threshold amplitude of about 30 percent occurs if a second harmonic of near-threshold amplitude is added to the fundamental. The magnitude of the depression depends critically on the relative phase of the two components of the waveform.

The frequency at which a flickering light appears to fuse into steady light has appeared to depend mainly on the average luminance and the amplitude of the fundamental Fourier component of the flicker waveform, and very little on its other components (1). However, recent results with a waveform whose second harmonic was much stronger than its fundamental (2) seemed to yield flicker fusion which depended on the amplitude of either the fundamental or the second harmonic, whichever was above threshold (3). This experiment was designed to check whether the threshold for flicker fusion is indeed not depressed when two components are summed, both components being near threshold.

The subject was seated with his head held fixed by a chin rest. A Sylvania R-1131/c glow modulator transilluminated a ground glass screen placed 10 inches from his eyes. The luminance could be varied without change of color by special circuitry provided by H. S. McDonald of Bell Telephone Laboratories. Only one average luminance was used in the experiments, namely 200 ft-lam. The screen subtended about 1° at the subject's eyes and was seen in a white surround of 40 ft-lam, subtending about 10°. The average d-c lamp luminance could be modulated in one of three modes selected by the subject by switch. These modes were: a sinusoid of frequency f , a sinusoid of frequency $2f$, and the two components summed. The experimenter set the frequencies and the relative phase of the components (see Fig. 1). The subject could vary the amplitude of modula-

tion in each mode independently. First, the subject set the amplitudes of f and of $2f$ to just exceed the threshold separately. He then left these settings undisturbed while he adjusted the amplitude of the sum of the two components according to the same criterion. He reset this amplitude for each of a set of phase differences selected by the experimenter. By switching back and forth among the three modes, the subject could compare his setting with those he had made for the sinusoidal modes. It was hoped in this way to compensate for possible shifts in threshold criteria during a run through a complete set of phases. Each subject made four such runs.

It should be noted that, above 15 cy/sec, equating the degree of flicker near threshold seems to be a straightforward task, uncomplicated by doubts about the comparability of flickers of different frequency. Under the given conditions, all flickers above about 15 cy/sec appeared to be of the same frequency. This is an effect noted by Bartley in an early paper (4).

The average settings of five subjects are plotted in Fig. 2, curves A and B . Each point therefore is the average of 20 settings. Standard deviations are indicated for only one point in each curve. The deviations were very nearly the same at all phases.

When the two flicker components were combined, all observers perceived the flicker more readily. They found it necessary to reduce the component amplitudes by 30 percent, on the average, to bring the percept as near to threshold as either component alone. They also found it necessary to reduce the amplitude by different amounts for different relative phases of the components. Thus, waveform does affect threshold. The reason this was not previously observed (1) is that only the fundamental was near threshold amplitude in the waveforms used. This result also conflicts with the conclusion I drew (3) from Brown and Forsyth's work (2): "as well as one can tell from the data, in the fusion region the observer responds independently to whichever component is above threshold." In Brown and Forsyth's data there were only two or three points for which both components were near threshold. Fortunately, the positions of these points may have missed indicating the slight depression of threshold to be expected.

The experimental results reported here suggest that the perceived flicker amplitude depends upon the peak-to-peak light amplitude for the flicker waveform. To check this hypothesis, the results are compared in Fig. 2 with the threshold variation expected from changes in the peak-to-peak amplitude as the relative phase of the two com-

ponents is varied. (The phase angle is defined as the lead of the positive-going zero-crossing of the low-frequency component with respect to that of the high-frequency component, in degrees of the high-frequency cycles.) Curve A shows the fraction of either component used to set flicker at threshold for various relative phases of 20 cy/sec sinusoidal flicker combined with 10 cy/sec; curve B shows the same for 40 cy/sec combined with 20 cy/sec; curve C shows the fractions to be expected were the flicker threshold determined only by the peak-to-peak amplitude of the waveform when the components are combined. It should be noted that curve C was computed on the basis of equal component amplitudes. Equal amplitudes were assumed because each component had been set at its particular threshold—that is, equal "sensation levels" of the two components are assumed. The fractions by which the combined amplitudes were reduced were almost what the peak-to-peak hypothesis might lead one to expect. However, the phase dependence is quite different from that pre-

dicted. It is true that the curve for high frequency (curve B) comes fairly close to C and does have a rise in the 270° region as predicted, but note that the rise is not significant compared with the indicated standard deviations.

Generally, curve B comes closer to C than A does, and this may indicate that at still higher frequencies the peak-to-peak prediction may be borne out more accurately. To check this, more intense light sources will have to be used.

The form of curve A clearly indicates on-versus-off asymmetry in the human flicker detection mechanism. Unlike curve C , which has a peak for every 180° of lead of the low-frequency component, curve A has a peak every 360° . The waveform of the light intensity modulation is inverted every 180° of phase lead. The 360° periodicity of A therefore shows that the peak-to-peak amplitude alone does not determine flicker threshold, but rather that the same waveform may be seen more readily in one polarity than when inverted. Of course, the difference is small, and observable only for wave-

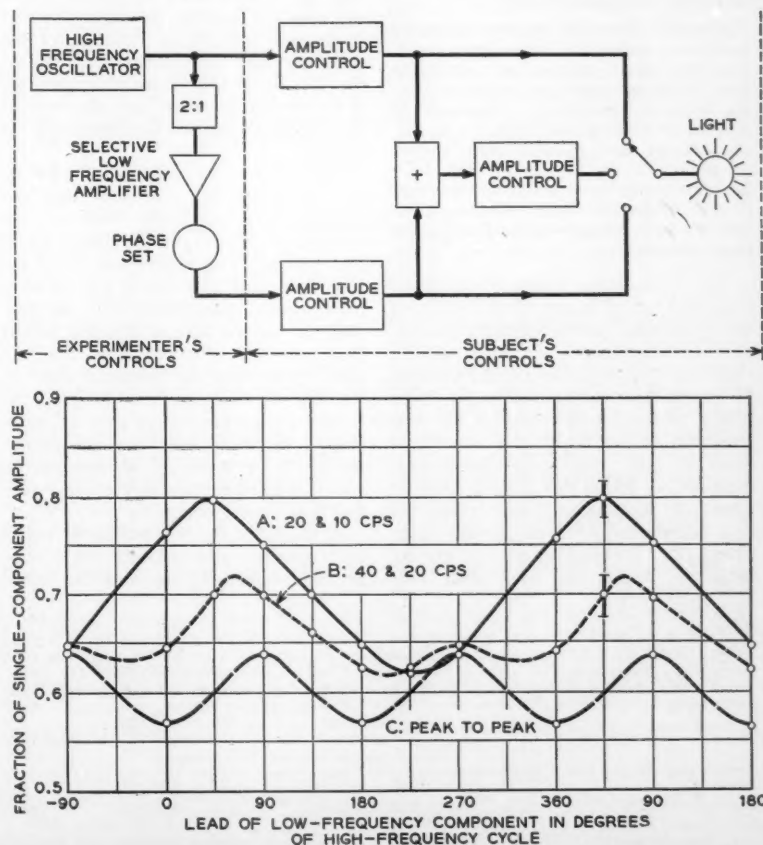


Fig. 1 (top). Apparatus used. Fig. 2 (bottom). Fusion amplitude as a function of phase difference between components.

forms having relatively weak fundamentals.

The information now available provides a fairly precise description of the time sequence of events in the retina during flicker fusion. Under the specific conditions mentioned above, flicker fusion thresholds do depend on waveform, contrary to previous opinion (1), and not upon one component alone (3, 5).

J. LEVINSON

Bell Telephone Laboratories,
Murray Hill, New Jersey

References and Notes

1. H. deLange, *J. Opt. Soc. Am.* **48**, 777 (1958).
2. C. R. Brown and D. M. Forsyth, *Science* **129**, 390 (1959).
3. J. Levinson, *ibid.* **130**, 919 (1959).
4. S. H. Bartley, *J. Exptl. Psychol.* **22**, 388 (1938).
5. A paper combining these considerations with results of H. deLange (1) and C. Enroth [*Acta Physiol. Scand.* **27**, suppl., 100 (1952)] is in preparation. Thanks are due to J. Kohut for assembling the apparatus and taking the data. The efforts of his patient subjects are also gratefully acknowledged.

1 February 1960

Is Reserpine Tranquilization Linked to Change in Brain Serotonin or Brain Norepinephrine?

Abstract. Reserpine, when administered to animals stressed by exposure to cold, does not induce sedation or appreciably lower brain serotonin, but markedly lowers brain norepinephrine. Reserpine in cold-exposed hypophysectomized rats elicits sedation and releases both amines equally. The results support the view that the tranquilizing action of reserpine is not related to brain norepinephrine loss but rather to change in the level of brain serotonin.

The tranquilizing action of reserpine, originally linked to the release of brain serotonin, is now often ascribed to the loss of brain norepinephrine. From studies based on bioassay, Kärki and Paasonen (1) concluded that Raunescine, in doses which release norepinephrine but not serotonin in the brain, has a sedative effect in rats. But, using fluorimetric methods, we found that various sedative doses of Raunescine lower serotonin and norepinephrine levels to the same extent (2). Pletscher *et al.* (3), on the basis of studies in mice with two

benzoquinolizine derivatives, proposed that the sedative action of reserpine is associated with loss of brain norepinephrine. They reported that in 1 hour the potent tranquilizer, Ro 4-1284, releases more brain norepinephrine than does the weak tranquilizer Ro 4-1398, while the two drugs release serotonin to the same extent. However, we found that whereas in 20 minutes Ro 4-1284 releases much more serotonin than does Ro 4-1398, in 1 hour the difference in serotonin levels disappears because the action of the former compound is brief and brain serotonin forms rapidly (2). Thus, the results with Raunescine and the benzoquinolizines do not make it possible to associate sedation with either one of the amines.

Contrary to findings of many other workers are those of Sheppard and Zimmerman (4), who reported that the subcutaneous injection of small doses of reserpine (0.1 mg/kg) into female guinea pigs causes in 20 minutes a rise of 75 percent in brain norepinephrine level, and in 2 hours a rise of 45 percent in heart norepinephrine level. After 2 hours they found a small decline in brain serotonin level. These authors measured norepinephrine fluorimetrically by a procedure in which filters are used for isolating the activation and fluorescent light bands. Because of the relatively wide spectral bands of filters, the validity of the values thus obtained is contingent on proof that the method for norepinephrine determination is specific.

This is especially relevant in view of the presence of reserpine and its metabolites in the body. However, no evidence is offered for the specificity of the method. The experiments were repeated in this laboratory (5) with a fluorescence spectrometer, which permits the use of narrow spectral bands. With methods of proved specificity we have shown that the administration of 0.1 mg of reserpine per kilogram to female guinea pigs at no time causes a rise in brain or heart norepinephrine levels. Brain levels of norepinephrine and serotonin decline at the same rate and to the same extent.

A study of the phenomenon, noted by Garattini and Valzelli (6), that administration of reserpine to cold-

exposed rats causes no sedation and no decline in the level of brain serotonin, led us to discover that, in animals subjected to stress, administration of reserpine considerably depletes the amounts of norepinephrine in the brain but does not elicit sedation or appreciably change the content of brain serotonin.

Rats (males, Sprague-Dawley, weighing 150 to 180 gm) after 4 hours' exposure to cold (4°C), were injected intraperitoneally with 1 mg of reserpine per kilogram. The animals were then kept in the cold for an additional 4 hours, during which time they gave no evidence of sedation. The rats were then decapitated, and the brains were analyzed for norepinephrine and serotonin by fluorimetric methods (7). As shown in Table 1, the reserpine released considerable amounts of brain norepinephrine but affected brain serotonin levels only slightly. Exposure of rats to cold for 8 hours without reserpine administration resulted in no change in the amine levels. Reserpine given to rats at room temperature (22°C), or to rats exposed only briefly to cold, elicited marked sedation and released both amines. Experiments with rabbits gave similar results.

A close association between the appearance of sedation and the release of brain serotonin was shown by experiments in which rats were exposed to cold for 4 hours, given reserpine, and then brought to room temperature. The levels of brain serotonin then slowly declined, and evidence of sedation appeared only when the serotonin level had declined by about 50 percent.

The possibility that "stress," produced by exposure to cold, prevented the decline in brain serotonin and the sedative action of reserpine was tested by administering the drug to cold-exposed, hypophysectomized rats. Under these circumstances, reserpine elicited sedation and released both amines. Hypophysectomized rats exposed to cold for 8 hours without reserpine showed no change in brain amine levels.

These studies suggest, but do not prove, a causal relation between the release of serotonin and the tranquilizing actions of reserpine. Other lines of evidence also indicate that the sedative action of reserpine is associated with changes in brain serotonin rather than changes in brain norepinephrine. For example, studies from our laboratory show that small doses of Su 5171 (dimethylaminobenzoyl methylreserpate) release relatively little brain serotonin in rabbits; the animals give no evidence of sedation, despite a marked decline in brain norepinephrine (2). Finally, recent reports indicate that the norepinephrine loss induced by reserpine does not lower sympathetic discharge from the central sympathetic system (8) and may even increase the outflow (9).

Table 1. Brain levels of serotonin and norepinephrine (\pm standard error) in rats exposed to cold stress. The animals were given 1 mg of reserpine per kilogram, intraperitoneally. Figures in parentheses refer to number of experiments. The brains of three animals were pooled in each experiment.

Treatment	Serotonin content (μ g/g)	Norepinephrine content (μ g/g)	Sedation
None	0.45 \pm 0.02 (15)	0.49 \pm 0.02 (15)	
Reserpine at 22°C	0.16 \pm 0.02 (15)	0.16 \pm 0.02 (15)	Yes
Brief (2 min) cold-exposure followed by reserpine at 4°C	0.19 \pm 0.02 (4)	0.19 \pm 0.03 (9)	Yes
Long (4 hr) cold-exposure followed by reserpine at 4°C	0.36 \pm 0.02 (9)	0.23 \pm 0.03 (9)	No

These results are in agreement with the possibilities that, on the release of stored amines in brain, total amine levels, but not necessarily free amine levels, are lowered, and that the central effects of reserpine depend on the levels of free amine at the receptor sites (9). Because of the very rapid synthesis of serotonin (10) as compared to norepinephrine (11) in brain, the effects of free serotonin may predominate after reserpine action.

F. SULSER
BERNARD B. BRODIE

Laboratory of Chemical Pharmacology,
National Institutes of Health,
Bethesda, Maryland

References

1. N. T. Kärki and M. K. Paasonen, *J. Neurochem.* **3**, 352 (1959).
2. B. B. Brodie, K. F. Finger, F. B. Orlans, G. P. Quinn, F. Sulser, *J. Pharmacol. Exptl. Therap.*, in press.
3. A. Pletscher, H. Besendorf, K. F. Gey, *Science* **129**, 844 (1959).
4. H. Sheppard and J. H. Zimmerman, *Nature* **185**, 40 (1960).
5. F. B. Orlans, unpublished.
6. S. Garattini and L. Valzelli, *Science* **128**, 1278 (1958).
7. D. F. Bogdanski, A. Pletscher, B. B. Brodie, S. Udenfriend, *J. Pharmacol. Exptl. Therap.* **117**, 82 (1956); P. A. Shore and J. S. Olin, *ibid.* **122**, 295 (1958).
8. A. Iggo and M. Vogt, *J. Physiol. London* **147**, 14P (1959).
9. B. B. Brodie, S. Spector, P. A. Shore, *Pharmacol. Revs.* **11**, 548 (1959).
10. B. B. Brodie, S. Spector, R. Kuntzman, P. A. Shore, *Naturwissenschaften* **45**, 243 (1958).
11. S. Udenfriend and R. C. Creveling, *J. Neurochem.*, in press.

18 December 1959

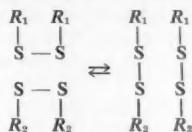
Disulfide Interchange by Ionizing Radiation

Abstract. The irradiation of a solution of two symmetric disulfides produces detectable amounts of the nonsymmetric mixed disulfide. The effect is abolished by the addition of ethylmaleimide. The finding indicates that radiation causes a disulfide opening and recombining process which may be of radiobiological interest.

The sulfur groups present in the structures of the cell have generally been considered some of the loci most vulnerable to radiation. The nature of the changes induced by radiation in these groups is not yet completely understood. In considering the possible extension of studies of simple systems to more complex ones, chemical changes in sulfur compounds of low molecular weight resulting from radiation have been frequently investigated. Researches have been focused on the degradation of these compounds (1) or on the oxidation (2) and the reduction (2, 3) of their sulfur portion. The occurrence of a less destructive action of ionizing radiation on sulfur compounds—that is, disulfide interchange—is reported here; though less destructive, this phenomenon might equally effect a disorganiza-

tion of disulfide-containing substances.

Disulfide interchange was studied in a system composed of cystamine and N-diformylcystine. This system permitted the use of compounds soluble over a large pH range and of paper electrophoresis for the detection of the interchange product. As a matter of fact, cystamine and diformylcystine, having different dissociation, migrate in opposite directions, while the mixed disulfide produced by the interchange



($R_1 = -CH_2-CH_2-NH_2$;
 $R_2 = -CH_2-CH(NHOCH)-COOH$)

having an intermediate charge, migrates at an intermediate rate.

Four hundred micromoles of cystamine dihydrochloride (4) were dissolved in 4 ml of the same acetate buffer that was used for electrophoresis; 400 μ mole of N-diformylcystine was suspended in 4 ml of water and brought into solution by the addition of solid sodium carbonate. The two solutions were mixed (final pH, 3.8 to 4.0) and irradiated for a suitable length of time with a Philips 50-kv x-ray source at a distance of 1 cm. The magnitude of the radiation dose was checked by a ferrous sulfate dosimeter. At any desired time a 0.02-ml sample of the solution was spotted at the center of a strip of Whatman 3-mm filter paper. The paper was then wetted with a 0.45M sodium acetate buffer of pH 3.75 (ionic strength, 0.05). Electrophoresis was performed in the same buffer, with a potential of 300 volts (about 10 volt/cm of paper), for 30 minutes. After the paper was dried the compounds were located by spraying with the Folin-Marenzi reagent, with bisulfite added according to a procedure previously devised for the detection of disulfides (5).

The results are shown in Fig. 1; they indicate that under the action of radiation a new disulfide compound, which in electrophoresis does not migrate, is promptly produced in amounts related to the radiation dose. In order to identify the new compound, larger amounts of it were prepared by large-scale electrophoresis. As was to have been expected from the mixed disulfide formed by interchange between cystamine and diformylcystine, upon oxidation with H_2O_2 and ammonium molybdate (6), followed by hydrolysis in 1N HCL for 2 hours at 100°C, the new compound yielded taurine and cysteic acid, which were detected by paper chromatography.

The radiation-induced disulfide exchange was observed also at neutral pH and with concentrations of the reactants other than those reported above. Be-

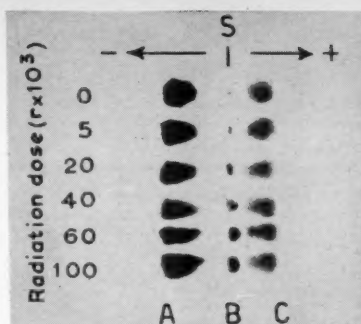


Fig. 1. Disulfide interchange by radiation. Paper electrophoresis of a solution of equimolar amounts of cystamine and diformylcystine after irradiation with increasingly large doses of x-rays. S, starting point; A, cystamine; C, N-diformylcystine; B, mixed disulfide. Spots were developed by spraying with the Folin-Marenzi reagent for disulfides.

cause of the slow spontaneous exchange (7), which tends to mask the results, the described conditions are the most suitable for a clear-cut demonstration of the radiation effect. The presence of an excess of N-ethylmaleimide abolishes the exchange; this indicates that the reaction probably proceeds through the temporary opening of the disulfide bonds with liberation of thiol groups. However, the nitroprusside test for thiol groups, carried out soon after irradiation of the solutions, was found invariably negative.

By slightly modifying the experimental conditions, so as to solubilize cystine (solution of the disulfides in final 0.2N HCL), the exchange can be observed also between cystine and cystamine.

Two conclusions should be drawn from the above results. First, the radiation-induced exchange can be expected to occur also within a single molecular species of disulfide. This effect of radiation, which is not followed by analytical change of the compound, might dissipate radiation energy, thus contributing to the reduction of the damaging action of radiation observed in the presence of disulfides. Second, present results, if extended to proteins, might provide another approach to the understanding of the disorganization of secondary and tertiary structures of disulfide-containing proteins brought about by radiation. In this connection, the disulfide interchange which has been reported to occur in the course of the chemical denaturation of proteins (8) and polypeptides (9) is highly suggestive (10).

D. CAVALLINI, B. MONDOVI,
B. GIOVANELLA, C. DE MARCO
Institutes of Biological Chemistry of the
Universities of Modena and
Rome and Regina Elena Institute
for Cancer Research, Rome, Italy

References and Notes

1. J. Kopoldova, J. Kolousek, A. Babicky, J. Liebster, *Nature* **182**, 1074 (1958); D. Cavallini, B. Mondovi, B. Giovannella, C. De Marco, *ibid.* **184**, 61 (1959).
2. B. Shapiro and L. Eldjarn, *Radiation Research* **3**, 255, 393 (1955).
3. R. S. Yaslow, *Proc. 1st Natl. Biophys. Conf.* (1959), p. 169.
4. The cystamine dihydrochloride used in this study was prepared from commercial mercaptoethylamine by the procedure of A. H. Nathan and M. T. Bogert [*J. Am. Chem. Soc.* **63**, 2361 (1941)].
5. D. Cavallini, C. De Marco, B. Mondovi, *J. Biol. Chem.* **234**, 854 (1959).
6. C. E. Dent, *Biochem. J.* **43**, 590 (1947).
7. A. P. Ryle and F. Sanger, *ibid.* **60**, 535 (1955); R. Benesh and R. Benesh, *J. Am. Chem. Soc.* **80**, 1666 (1958).
8. C. Huggins, D. F. Tapley, V. Jensen, *Nature* **167**, 592 (1951); W. Kauzmann and R. G. Douglas, *Arch. Biochem. Biophys.* **65**, 106 (1956).
9. C. Ressler, *Science* **128**, 1281 (1958).
10. This work was supported by grants from the Consiglio Nazionale delle Ricerche and from the Comitato Nazionale Ricerche Nucleari.

23 November 1959

Rh₀(D) Genotype and Red Cell Rh₀(D) Antigen Content

Abstract. The Rh₀(D) content of red cells obtained from different individuals as determined with I^m anti-Rh₀(D) showed a bimodal distribution. Family studies indicate that the cells with the lower antigen content represent the heterozygous Rh₀(D) state and that the cells with 1.6 times more Rh₀(D) correspond to the homozygous state.

The blood group antigens on the stroma of the red cell represent specific immunochemical molecules whose synthesis is genetically determined (1). If the one gene-one product hypothesis applies to the blood group antigens, the red cell derived from a homozygous individual should have twice the antigen content found on a red cell derived from a heterozygous individual.

The Rh₀(D) antigen content of the human red cell was determined with incomplete I^m trace labeled anti-Rh₀(D) and the methods described previously (2). The method of approach was to determine the frequency distribution of the Rh₀(D) antigen content in a population of different Caucasian red cells (3). The heterozygous state in this distribution then was identified by study of genetically defined Rh₀(D) heterozygous cells obtained from family studies. The use of this experimental approach was necessitated because of the inability to differentiate in advance of the experiment the heterozygous from the homozygous Rh₀(D) red cell by conventional techniques (4).

Red cells were obtained by selection from the donor population entering the Blood Bank (5) and were typed for the ABO and Rh antigens with commercially obtained antisera. Only a few Rh₀(D) negative red cells were used as controls. The red cells from 199 indi-

viduals were studied, but only the results obtained on rh'(C) negative, Rh₀(D) positive cells are presented in this report. The results are expressed as quantity of antibody nitrogen bound to 0.01 ml of centrifuged red cells as determined by the microhematocrit technique (6) using the International microhematocrit centrifuge (5 minutes at $g_{max} = 12,000$). The mean number of red cells in 0.01 ml of centrifuged red cells was determined for a number of cell suspensions with the Coulter electronic counter (7, 8) and was found to equal $9.01 \pm 1.48 \times 10^7$ cells (9).

The over-all precision of the technique was evaluated by the following experiment. Red cells from a given individual were stored in Alsever's solution at 4°C and on subsequent days an aliquot was reconstituted and reacted with the I^m anti-Rh₀(D). A fresh specimen of cells obtained from the same individual was run in parallel with the stored cells. The mean and standard error of the mean for repeated determinations on the stored cells over a period of 11 days was 1.85 ± 0.13 , 10^{-3} μ g of N per 0.01 ml of red blood cells. The corresponding value for fresh unstored red cells was 1.85 ± 0.15 , 10^{-3} μ g of N. There was no significant difference between these two values ($t = 0.18$, $n = 14$). Rh₀(D) negative red cells took up less than 3 to 7 percent of the I^m bound to Rh₀(D) positive red cells. The amount of nitrogen bound was independent of both the Rh and ABO phenotype of the Rh₀(D) negative cell. All the red cell suspensions were reacted in an excess of antibody in order to obtain maximum saturation of the Rh₀(D) antigen sites. Antibody excess was determined by demonstrating free I^m anti-Rh₀(D) in the supernatants after reaction and by re-reacting the I^m-sensitized red cells with additional I^m anti-Rh₀(D) to show that the available antigen sites were saturated. There was less than 10 percent increase in the amount of antibody bound to the sensitized red cell after a second 60-minute incubation with the I^m anti-Rh₀(D).

The absolute frequency of the antibody nitrogen bound to 47 Rh₀(D) positive, rh'(C) negative cells is shown in Fig. 1. It can be seen that the cells segregate into two groups, one with a mean of 2.44 and the other with a mean of 3.95 (10^{-3} μ g of N per 0.01 ml of red blood cells). The cells in the higher nitrogen value group take up 1.62 times more antibody nitrogen than do the cells in the lower group. Known heterozygous Rh₀(D) positive red cells obtained from families with a history of Rh hemolytic diseases of the newborn (10) were employed to identify the heterozygous value in this bimodal distribution. Eight genetically determined

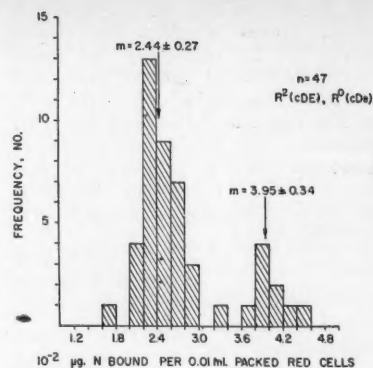


Fig. 1. Distribution of I^m anti-Rh₀(D) nitrogen bound to 47 different Rh₀(D) positive, rh'(C) negative red cells. The values shown are in units of 10^{-3} μ g of nitrogen per 0.01 ml of centrifuged red cells with the mean and standard error of the mean shown for each group.

heterozygous Rh₀(D) positive red cells had values which ranged from 1.47 to 2.48 (10^{-3} μ g of N per 0.01 ml of red blood cells). These results indicate that the 2.44 antibody nitrogen peak represents the heterozygous state [Rh₀(D), rh(d)] and that the 3.95 value corresponds to the homozygous state [Rh₀(D), Rh₀(D)]. If certain assumptions are granted, namely uniformity of iodination of the globulins in the gamma globulin fraction and a molecular weight of 1.6×10^6 for the anti-Rh₀(D), then the heterozygous Rh₀(D) red cell contains about 6400 Rh₀(D) antigen sites per cell and the homozygous cell about 10,300 per cell (11).

S. P. MASOUREDIS

Department of Preventive Medicine and Cancer Research Institute, University of California Medical Center, San Francisco

References and Notes

1. R. R. Race and R. Sanger, *Brit. Med. Bull.* **15**, 99 (1959).
2. S. P. Masouredis, *J. Clin. Invest.* **38**, 279 (1959).
3. S. P. Masouredis, *ibid.* **38**, 1024 (1959).
4. R. R. Race and R. Sanger, *Blood Groups in Man* (Blackwell, Oxford, England, ed. 3, 1958).
5. Central Blood Bank of Pittsburgh, University of Pittsburgh Medical Center, Pittsburgh, Pa., where this study was initiated.
6. J. J. McGovern, A. R. Jones, A. G. Steinberg, *New Engl. J. Med.* **253**, 308 (1955).
7. C. F. T. Mattern, F. S. Brackett, B. J. Olson, *J. Appl. Physiol.* **10**, 56 (1957).
8. The interest of Dr. R. C. Hamilton and Sister Marietta of St. Francis Hospital, Pittsburgh, in performing these determinations is gratefully acknowledged.
9. Mean and standard error of the mean are used throughout this report.
10. Dr. Paul Gaffney and Dr. William Chapman of Pittsburgh, Pa., generously made available their patients for this study.
11. The technical assistance of Cecile Ann Chi and Elizabeth Ferguson is gratefully acknowledged. This study was supported by grant H-5071 from the National Heart Institute, U.S. Public Health Service.

22 January 1960

Stimulation of Frontal Cortex and Delayed Alternation Performance in the Monkey

Abstract. Unilateral or bilateral stimulation of the region surrounding the sulcus principalis of the cortex of the monkey interferes with delayed alternation performance. It is without effect on auditory discrimination performance. Bilateral stimulation is more disrupting than unilateral stimulation. The impairment is limited in time to the period of stimulation and is fully reversible.

That delayed response and delayed alternation performance of monkeys are severely impaired by surgical lesions of the lateral frontal cortex has been firmly established during the past 20 years (1). The present report is concerned with the effect of electrical stimulation of regions of the frontal lobes on delayed alternation and discrimination performance. Traditionally, electrical stimulation of the cerebrum has been used as an evoking stimulus, producing such phenomena as "motor maps," "sham rage," and "ergotropic" and "trophotropic" responses. More recently it has been used as a rewarding or punishing stimulus (2). Less frequently have its effects on the efficiency of on-going behavior been observed, at least in a systematic fashion; this is especially true where no obvious motor or reward effects are apparent. Such a use of stimulation was adopted by Rosvold and Delgado (3), who showed that stimulation of the caudate nucleus impaired delayed alternation behavior. But there have been, as yet, no reports of the effects of stimulation of the frontal cortex on this type of behavior. The results of the study reported here suggest that the technique might be rather more powerful than surgical lesion for the analysis of cortical function.

The electrodes were designed to permit the fine silver ball contacts (0.8 mm in diameter) to rest upon the cortex near the banks of sulcus principalis and sulcus arcuatus. Each electrode contained 13 points, implanted in each hemisphere according to the technique of Delgado (4). The positions of the contacts in one animal, as determined by post-mortem examination, are shown in Fig. 1. Stimulation was applied between the points that are joined by lines. Principalis points are joined by lines ventrally adjacent to the points; arcuatus points, by lines dorsally adjacent. In our study only principalis points or arcuatus points were stimulated—never both simultaneously. The stimulus was a unidirectional square wave (duration, 0.2 msec; frequency, 100 cy/sec), generated by a Grass stimulator. During any stimulation condition, pulses were delivered repeatedly

for periods of 1 second, with 3 seconds of nonstimulation between presentations. This pattern of stimulation was begun at the beginning of the first trial of a stimulation session and continued without interruption until the end of the last trial; hence, the animal was stimulated both during a trial and between trials. The voltages for each animal for each mode of stimulation (to principalis and to arcuatus) were selected prior to the commencement of formal testing so as to be 1 or 2 volts below the threshold for overt motor responses.

Prior to implantation, three young macaque monkeys (each weighing about 3 kg) were trained to perform delayed alternation, auditory discrimination, and visual discrimination tasks (5). All testing was carried out in a Wisconsin general testing apparatus. For the delayed-alternation task the animal was presented with two covered food wells. On successive trials (between trials an opaque screen was lowered for 7 seconds) the animal was required to lift the cover that he had not lifted on the prior trial. In the auditory problem the two stimuli to be discriminated consisted of a white noise and a pure tone of 1000 cycles, each interrupted briefly three times per second and each approximately 70 db above the room noise level. The animal was required to lift a food-well cover when the white noise was presented and to refrain from lifting the cover when the tone was presented. Correct responses to either stimulus were rewarded. In both the delay and the auditory tasks, correction trials were run. All animals learned the tasks sufficiently well to satisfy a criterion of 90 correct responses in 100 successive trials (exclusive of correction trials).

After implantation, various orders of testing were employed which cannot be described in detail here. It should be



Fig. 1. Position of electrode contacts as determined by post-mortem examination. It should be noted that the markers in the photograph are about 2.5 times the size of the actual contacts, which were 0.8 mm in diameter. Lines ventrally adjacent to pairs of contacts connect arcuatus stimulation points; lines dorsally adjacent connect principalis stimulation points.

mentioned that the stimulation testing for delayed alternation was carried out intermittently over a period of more than 2 months, during which time the effect was quite stable. Typically, the animal was given 30 control trials without stimulation, then 30 trials with stimulation, followed by another 30 control trials, although the last step was not always taken. Within each session, stimulation and nonstimulation periods followed each other without any time gap between.

In Table 1 are listed the results of stimulation of sulcus principalis and sulcus arcuatus upon delayed alternation and auditory discrimination. It will be seen that there is a very clear effect of bilateral principalis stimulation upon delayed alternation ($P < .0005$). In fact, the behavior is not significantly better than chance. Unilateral stimula-

Table 1. Ratios of correct to total trials.

Animal	Delayed alternation			Auditory discrimination		
	Before stimulation	During stimulation	After stimulation	Before stimulation	During stimulation	After stimulation
<i>Bilateral principalis</i>						
B-2	104/120	* 57/120	* 52/60	77/90	71/90	28/30
B-3	81/90	* 44/90	* 30/30	80/90	77/90	22/30
B-4	85/90	* 54/90	† 27/30	84/90	84/90	26/30
Av. percent	90.4	* 51.9	* 92.2	90.0	85.9	84.4
<i>Unilateral principalis</i>						
B-2	178/180	* 118/180	* 86/90			
B-3	212/230	* 153/250	* 117/140			
B-4	144/150	* 100/150	† 29/30			
Av. percent	95.8	* 64.5	* 92.0			
<i>Bilateral arcuatus</i>						
B-2	81/90	81/90	29/30	75/90	78/90	29/30
B-3	78/90	84/90	29/30	77/90	77/90	26/30
B-4	80/90	75/90	29/30	84/90	86/90	29/30
Av. percent	88.6	88.9	96.7	87.7	89.3	93.3

*.0005 > P (one-tailed chi-square); †.005 > P > .0005.

tion also has a clear but less marked effect ($P < .0005$). Neither arcuatus nor principalis stimulation affected auditory discrimination, a point clearly relevant to results from experiments with surgical lesions (6).

A few points bear emphasizing. Arcuatus stimulation is without effect on delayed alternation; this finding reinforces a view derived from experiments with surgical lesions that the focus for the deficit is to be found near sulcus principalis. However, the division is not made as sharply with surgical lesions. Second, the poststimulation control period for delayed alternation yields scores as good as those of the prestimulation period. Hence, it appears that the deficit literally can be turned on and off at the discretion of the experimenter. Finally, it should be stressed again that no overt motor responses to stimulation were evident, nor could one detect any change in the animals' motivation or willingness to be tested. Indeed, with the parameters of stimulation employed, the only reliable behavioral indication that the stimulation was having any effect whatsoever was the inability of the animals to perform delayed alternation tasks.

It appears, therefore, that electrical stimulation can reproduce some of the effects of surgical lesions in the frontal region. It also has certain clear advantages over lesions that commend its wider use for the analysis of cortical function. The deficit appears to be fully reversible, and hence each animal can be used as its own control. Indeed, there would seem to be no obstacle to obtaining "double dissociation" within a single organism. Furthermore, electrical stimulation appears to permit a somewhat finer fractionation than is possible with surgical lesions. Finally, certain types of questions, such as those involved in separating the effects on short-term storage from the effects on long-term storage, cannot be unequivocally answered with surgical lesions because these questions are of the form: Is behavior acquired during a "lesion" state altered in a subsequent "non-lesion" state? (7).

LAWRENCE WEISKRANTZ
LJUBODRAG MIHAILOVIĆ*
CHARLES G. GROSS†

Psychological Laboratory,
University of Cambridge, England

References and Notes

1. K. L. Chow and P. J. Hutt, *Brain* **76**, 625 (1953).
2. J. Olds and P. Milner, *J. Comp. Physiol. Psychol.* **47**, 419 (1954).
3. H. E. Rosvold and J. M. R. Delgado, *ibid.* **49**, 365 (1956).
4. J. M. R. Delgado, *Electroencephalog. and Clin. Neurophysiol.* **7**, 637 (1955).
5. A paper describing the visual discrimination tasks is in preparation.
6. L. Weiskrantz and M. Mishkin, *Brain* **81**, 406 (1958).
7. We are pleased to acknowledge the assistance of S. Hopkins and R. Hutchison. This research was supported in part by the Air Research and Development Command, U.S. Air Force.
- * On leave from the Medical School, University of Belgrade, Belgrade, Yugoslavia.
- † U.S. Public Health research fellow.

8 February 1960

Glacial Retreat in the North Bay Area, Ontario

Abstract. Geological and palynological studies in Ontario and Quebec, supported by radiocarbon dates, suggest that the opening of the North Bay outlet and the initiation of the Stanley-Chippewa stages in the Huron and Michigan basins took place 10,000 to 11,000 years ago.

Deglaciation of the vicinity of North Bay, Ontario, opened a discharge channel to the east by the way of Mattawa and Ottawa river valleys, initiating the low-water Stanley and Chippewa stages in the Huron and Michigan basins. This event provides an ideal starting point for a chronology of deglaciation of the region north of the Great Lakes.

Opening of the North Bay outlet is generally judged to have taken place about 6000 years before the present (B.P.) (1, Table 22), but new radiocarbon dates suggest that this event may have occurred 4000 to 5000 years earlier. The dates may be divided into two categories: (i) minimum dates for deglaciation of localities in the vicinity of North Bay, which may be used directly as minimum dates for the opening of the North Bay outlet; (ii) minimum dates for events recorded in deposits of the glacial Lake Barlow-Ojibway (Fig. 1) of northern Ontario and Quebec, and James Bay Lowland. To these dates must be added estimates, based on varve counts and extrapolations, of the number of years required for the ice margin to retreat from North Bay to the localities concerned.

The Champlain Sea reached its highest limits at Ottawa some 10,000 to 11,000 years ago (2), and the post-Champlain Sea peat in the St. Lawrence Lowlands has been dated at about 9500 years (3). Terasmae (2, 3) has suggested that the Champlain Sea episode is in part contemporaneous with the Valdres substage. Recent studies indicate that the ice had retreated north of Pembroke and Deep River, latitude about 46° north, during the Champlain Sea episode. This reasoning suggests an age of about 10,000 years for the opening of the North Bay outlet.

Lee (4) established a minimum age of 9130 ± 350 years (sample W-345) for the archeological site at Sheguiandah on Manitoulin Island. This date on a bog bottom sample (elevation about 720 feet) is a minimum date for post-

Lake Algonquin time in the Huron basin. A pollen diagram for the Sheguiandah bog (4) correlates well with two other radiocarbon dated pollen sequences from High Hill bog and Little Current bog, Manitoulin Island. An age of 9560 ± 110 years (sample GRO-1926) for the bog bottom sample from the High Hill bog (elevation about 860 feet) is a minimum age for early post-Lake Algonquin time. The Little Current bog (elevation about 1010 feet) is above the highest postulated level of Lake Algonquin (1) and provides a pollen sequence beginning shortly after deglaciation of that locality. A sample of the basal organic deposit in this bog was dated at 9450 ± 350 years (sample I GSC-3), but the pollen sequence begins in the underlying silty clay, indicating that deglaciation of the site took place some time earlier.

A sample of basal peat and a pollen profile were collected from a bog in the Fossmill channel, the earliest proposed outlet at North Bay. This sample was dated at 6090 ± 85 years B.P. (sample GRO-1924). However, the palynological evidence shows that mixed hardwood forest (including hickory and walnut) grew near this site at the time, and hence the ice retreat from Fossmill must have occurred much earlier.

Palynological studies about 10 miles north of North Bay, made by Ignatius (5) and by Terasmae have shown that lacustrine deposits and peat began to accumulate there about 9500 years ago.

Clay varves number 1163 to 2027 of Antevs' Timiskaming series (6), deposited in glacial Lake Barlow-Ojibway, have been remeasured at 12 localities (7) scattered through a north-south distance of 50 miles and an east-west distance of 56 miles. Varve diagrams prepared from these measurements show good agreement with one another and with diagrams prepared by Antevs (6, 7), especially for "normal" varves. Agreement is less satisfactory for those parts of the diagrams which represent thick proximal varves, or thin ultra-distal varves. The restudy confirms Antevs' counting of the varves and his calculations of the rate of retreat of the ice sheet northward across the basin of glacial Lake Barlow-Ojibway.

The rate of ice retreat, from 454 feet (8, p. 143) to 926 feet per varve cycle (7, p. 160) is compatible with interpretation of the varves as annual deposits, but not with interpretation of them as diurnal deposits. Terasmae has found that pollen is markedly more abundant in the silt layers than in the clay layers of the same varves. Distribution of the pollen is best explained by assuming that the silt is a summer layer, the clay a winter layer, and the

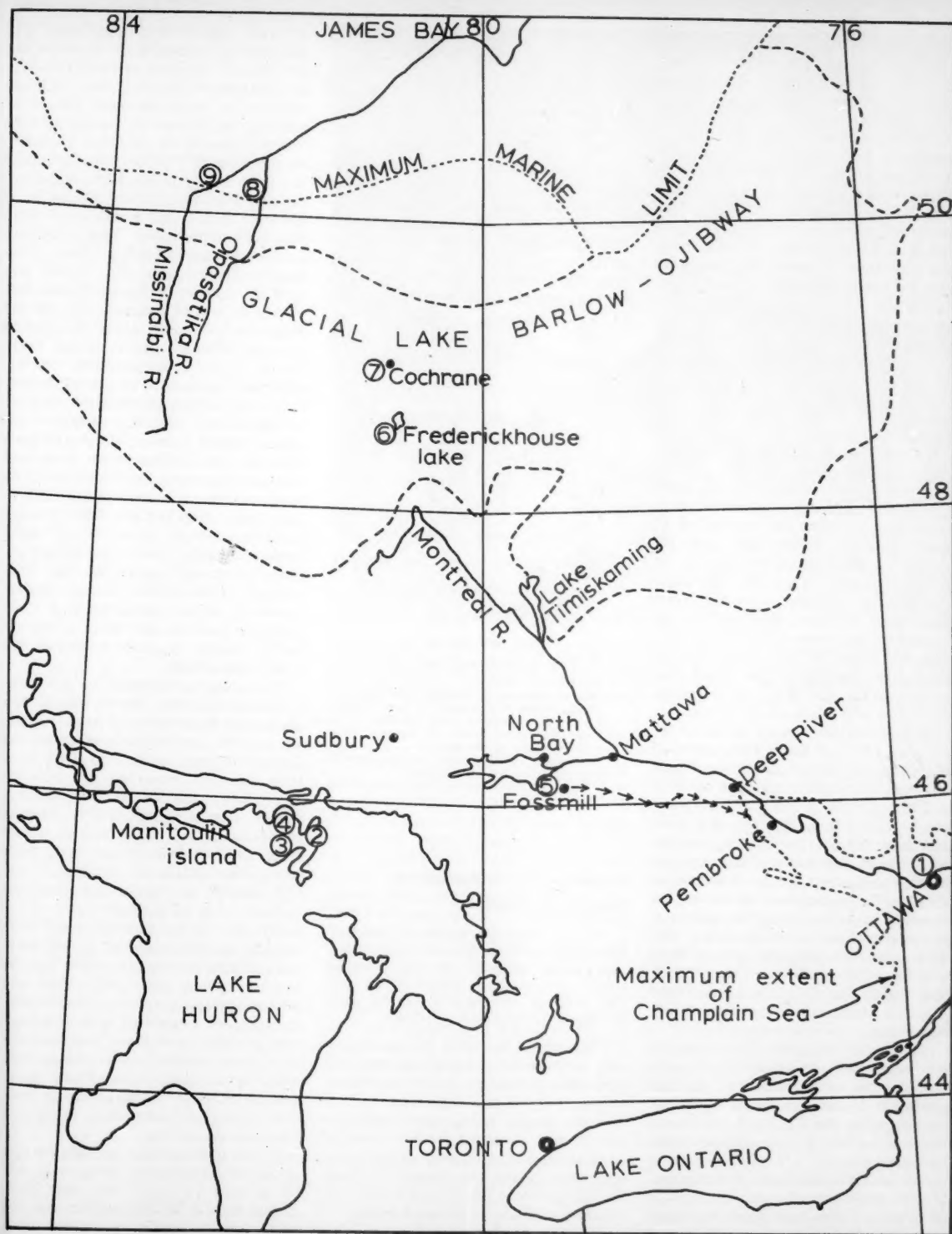


Fig. 1. Index map showing localities where samples dated by radiocarbon methods were taken. The dates and sample numbers follow: 1, Ottawa, $10,850 \pm 330$ years (Y-216); 2, Manitoulin Island, 9130 ± 350 years (W-345); 3, Manitoulin Island, 9560 ± 110 years (GRO-1926); 4, Manitoulin Island, 9450 ± 350 years (I GSC-3); 5, Fossmill, 6090 ± 85 years (GRO-1924); 6, Frederickhouse Lake, 6730 ± 200 and 6970 ± 310 years (Y-222); 7, Cochrane, 6380 ± 350 years (W-136); 8, Opatatika River, 7280 ± 80 years (GRO-1698); 9, Missinibi River, 7875 ± 200 years (I GSC-14).

silt-clay couplet an annual deposit. We therefore believe that the classic interpretation of varves as annual deposits applies to the varves deposited in glacial Lake Barlow-Ojibway.

Antevs measured some 2027 varves, beginning with varve 1 at the base of a section at the mouth of Montreal River, where it enters Lake Timiskaming. Some 58 varves have since been measured above varve 2027, bringing the total to 2075 (7). The Cochrane ice readvance, recorded by widespread clay till overlying disturbed varved clay (there is no terminal moraine) is judged to have culminated in year 2025 of the varve chronology (7, 8)—that is, 2025 years elapsed from the beginning of deposition of varve 1, when the ice margin stood just north of the mouth of Montreal River, to attainment of the Cochrane maximum. Antevs calculated that the ice margin retreated 454 ft/yr in the southern part of the Barlow-Ojibway basin (8, p. 143). Extrapolation of this rate southward to cover retreat across the interval of 57 miles between North Bay and the mouth of Montreal River gives a result of 670 years. Thus, the time interval between the opening of the North Bay outlet and the attainment of the Cochrane maximum was about 2025 plus 670 years, or 2695 years, and between the opening of the North Bay outlet and the end of the varve record, 2075 plus 670 years, or 2745 years.

A bog bottom sample collected by Ignatius (5) and Elson from south of the limit of the Cochrane readvance (9) yielded radiocarbon ages of 6730 ± 200 and 6970 ± 310 years B.P. (sample Y-222). The sample was of a shell-rich layer 10 to 15 cm thick, overlain by 3.5 m of peat and underlain by gray homogeneous clay; the same succession overlies the uppermost varves of the standard sequence along the shores of the nearby Frederickhouse Lake. This date gives a minimum age of 6970 years B.P. for deposition of varve 2075, and 6970 plus 2745 years or 9715 years B.P. for the opening of the North Bay outlet.

Sample W-136, collected by T. N. V. Karlstrom (10), provides a minimum age of 6380 ± 350 years B.P. for deglaciation of the vicinity of Cochrane, Ontario, after the Cochrane readvance. There is no record of the retreat of the Cochrane ice lobe after its advance to a position 21 miles south of Cochrane. If 200 years are allowed for the uncovering of the Cochrane site, then we may calculate a minimum date of 6380 plus 200 plus 2695 years, or 9275 years for the opening of the North Bay outlet.

Even earlier opening of the North Bay outlet is implied by dates on shells

from near the upper limits of the marine submergence along Opasatika and Missinaibi rivers. The respective radiocarbon ages of 7280 ± 80 (sample GRO-1698) and 7875 ± 200 years (sample I GSC-14), agree fairly well with each other. The older date is taken as a minimum age for the beginning of the marine episode. If 400 years are allowed for ice retreat from the Cochrane maximum to the opening of James Bay Lowland to marine invasion, we arrive at a date of 7875 plus 2695 plus 400 years, or 10,970 years B.P. for the opening of the North Bay outlet (11).

J. TERASMAE
OWEN L. HUGHES

Geological Survey of Canada,
Ottawa, Ontario

References and Notes

1. J. L. Hough, *Geology of the Great Lakes* (Univ. of Illinois Press, Urbana, 1958).
2. J. Terasmae, *Science* 130, 334 (1959).
3. —, *Geol. Survey Can. Bull. No. 56* (1959).
4. T. E. Lee, *Can. Field-Naturalist* 71, 117 (1957).
5. H. Ignatius, unpublished thesis, Yale Univ., 1956.
6. E. Antevs, *Geol. Survey Can. Mem. No. 146* (1925).
7. O. L. Hughes, unpublished thesis, Univ. of Kansas, 1959.
8. E. Antevs, *Am. Geogr. Soc., Research Ser. No. 17* (1928).
9. O. L. Hughes, *Geol. Survey Can. Paper No. 55-41* (1956).
10. T. N. V. Karlstrom, *U.S. Geol. Survey Bull. No. 1021-J* (1956).
11. We are indebted to Professor H. de Vries of Groningen, Netherlands, for several radiocarbon measurements, and to Dr. J. G. Fyles, Geological Survey of Canada, for a critical reading of the manuscript. This paper is published by permission of the director, Geological Survey of Canada.

11 January 1960

Experimental Production of Mongoloid Hamsters

Abstract. Hamsters injected at birth with fractions or cell-free filtrates of transplantable human tumor cells as well as certain tissues derived from human beings and rats carrying spontaneous cancers have developed a mongoloid deformity.

This report describes an experimentally induced deformity in hamsters that resembles mongolism (1). It is characterized by small size, flat face or microcephalic domed head, protruding eyes and tongue, abnormal teeth or absence of teeth, and bone fragility (Figs. 1-4). The animals are less pugnacious than normal hamsters, live amicably with one another, and can be handled readily.

The phenomenon was observed incidentally during a series of experiments wherein fractions of transplantable human tumor cells (2), prepared by ultracentrifugation or sucrose gradient techniques, were utilized for antigen studies

(3) and injected into rats, mice, and hamsters of various ages. None of the rats or mice, whether newborn or older, ever exhibited abnormalities, although more than 50 litters were treated in each species. However, among the 100 litters (Table 1) of newborn hamsters, (comprising 932 babies) that received the fractions, 81 mongoloid animals appeared. They were evenly divided as to sex (41 males, 40 females), a ratio that has continued in further experiments. The single injection given to the babies, immediately after birth, was 0.03 ml, or less, of material suspended in 0.25M or 0.88M sucrose (3). All the fractions produced some mongoloid animals. Though the injections were usually given subcutaneously, the results were the same if an intraperitoneal route was employed. Hamsters that received control injections of 0.25M sucrose, 0.88M sucrose, Locke-Ringer's solution, or distilled water remained normal. The mongoloid effect could be produced up to 2 and, occasionally, 3 days after birth but not later. Twenty pregnant mothers given 0.5-ml doses intraperitoneally 1 to 4 days before delivery produced large litters that were normal. At the present writing, mothers are being treated earlier in their pregnancy and a large number of babies are being injected *in utero* at various periods before birth.

Tests were undertaken to determine if tissues other than the six tumors first studied (H Ep 3, HS 1, H Ad 1, H Emb Rh 1, A-42, and H Ep 5) contained the factor. As seen in Table 1, 185 newborn hamsters were injected with tumor, liver, and spleen fractions obtained from a patient with carcinoma of the liver. One baby, injected with a fraction of "normal" liver area from this patient, became a mongoloid animal, entirely similar to the others described. In a subsequent series of experiments, it was found possible to induce the deformity in a few hamsters injected with fractions of the livers or spleens of cancer patients, and of rats carrying spontaneous tumors. Spontaneous tumors of human beings, rats, or mice and tissue fractions derived from normal human beings, rats, mice, or hamsters were found to be without activity, as were tissue fractions prepared from adult mongoloid hamsters themselves.

It was not possible to tell whether or not the babies were going to be odd for at least 10 to 14 days after birth. At this time it became evident that the mongoloid babies were smaller than normal babies and that their faces were flatter. Many also had long, needle-like, curved teeth that made the mother refuse to nurse them. When the babies began to supplement their nursing at

approximately 14 days of age, the little mongoloid animals were at a great disadvantage because of their bizarre dentition or, conversely, their total lack of teeth. In the first series of animals (group 1), many were lost because this difficulty was not recognized. After a soft mush diet was provided, the survival rate increased greatly.

At 25 days of age, some of the affected hamsters weighed as little as 15 to 25 gm, while normal animals on the same diet weighed approximately 60 gm. As the animals grew older there was less discrepancy between the two groups. The average weight of the 54 animals that have survived over 1 year from the 82 mongoloid hamsters in group 1 is 90 gm (variation, 68 to 140 gm) as compared with 160 gm for control hamsters of the same age. It has been necessary to feed the mongoloid hamsters a soft diet throughout life, and those with peculiar dentition must have their teeth cut once a week. Their coats compare favorably with those of the normal animals (4). Eye infections, probably due to their exophthalmos, have been a common problem. Given good care, however, they live as long as the average laboratory hamster. Of the 28 mongoloid animals no longer surviving from the original 82, only ten died from disease or accident. Eight were used for I^{131} studies, four were used for a thyronine experiment, and six died in shock immediately after a small dose of streptomycin was given for a mild eye infection. No tumors have been observed in any of the animals.

When affected hamsters were autopsied, their internal organs showed few morbid changes. The thyroids were unremarkable, as had been indicated by the I^{131} uptake studies (5), which gave results within normal limits. The pituitaries, when examined histologically, also appeared normal. Several of the adrenals were hemorrhagic, with abnormal cortical structure, and some of the male testes were underdeveloped. (Nevertheless, at least ten litters, sired by mongoloid fathers, were delivered and raised by mongoloid mothers; these babies have been entirely normal and have grown to be much larger than their parents.) The most consistent find-

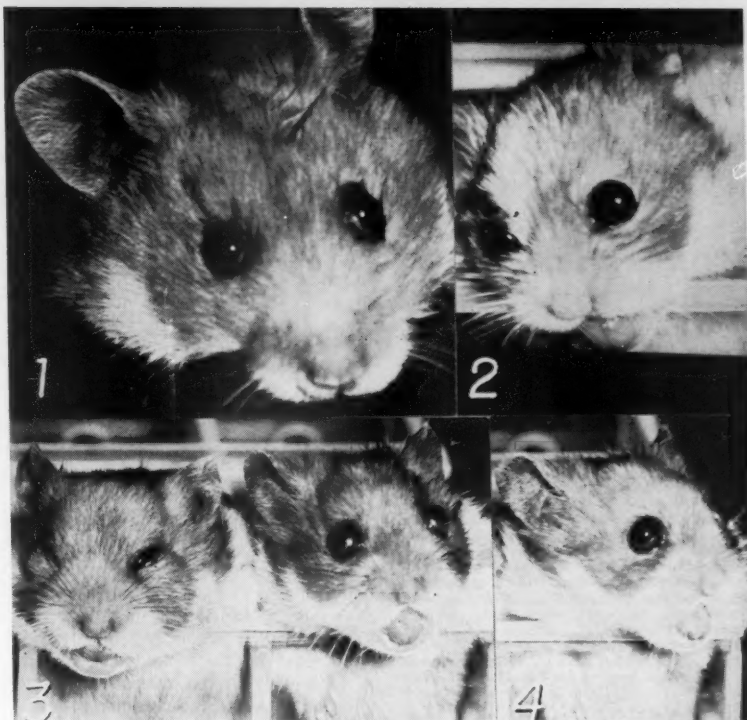


Fig. 1. Normal hamster. Note the pointed face. Figs. 2-4. Mongoloid hamsters. The protruding tongues and extreme exophthalmos are evident. The animal in Fig. 2 is the same age as that in Fig. 1. The animal on the left in Fig. 3 has slanted eyes, which are occasionally seen. The hamster on the right in Fig. 3 is shown again, side view, in Fig. 4.

ing was a fragile bone structure and, in particular, paper-thin skulls. The eyes appeared to be of normal size. Indeed, the protrusion of the eyes and tongue may have been an expression of the microcephaly. It is interesting that three of the affected hamsters died with extensive fatty degeneration of the liver, an observation which has been reported in human mongolism (6).

The effective factor or factors in the fractions used for group 1 was remarkably stable. These materials had been prepared from either fresh or frozen (-79°C) tumor and stored at 4°C , or frozen at -79°C and then thawed and refrigerated. Such preparations remained active for 6 months or more. Refreezing did not damage their effi-

cacy. Heating in boiling water for 15 minutes, however, completely destroyed activity, as a rule.

At the present time, few fractions are being employed for continued studies since cell-free filtrates, prepared by putting a tumor or tissue homogenate, suspended in distilled water, through a 0.03 Selas filter, have proved active. The percentage of mongoloid hamsters produced by filtrates of some tumor tissues (for example, H Ep 3 or A-42) is 100 percent, and thus an ideal model system can be constituted.

Electron-microscope studies of potent fractions and cell-free filtrates have thus far disclosed no foreign or abnormal particulate structures. These studies are being continued. Whatever the factor may be, it can be neutralized completely by normal Wistar rat serum, used in dilutions of 1 part serum to 3 parts effective material. This serum activity was not lost after heating at 56°C for 60 minutes. Rat serum, refrigerated for 6 months or more, and serum from x-irradiated rats were effective also. Fresh or refrigerated sera of other animals (guinea pig, rabbit, mouse, or chicken) were less protective than the rat serum, while a number of human

Table 1. Summary of data on experimental production of mongoloid hamsters.

No. litters	No. babies injected	Injected with	No. survivors (3+ months)	No. mongoloid animals
100	932	Fractions	144	81
19	198	Control solutions	164	0
19	185	Tissues of cancer patient	120	1
138	1315		428	82

and hamster sera were entirely free of inhibitory activity. Lyophilized human serum fractions also failed to inhibit the effect of a potent filtrate.

The data cited in the last two paragraphs were obtained from observations on 5500 hamster babies injected since group 1 was done (7).

HELENE W. TOOLAN
Sloan-Kettering Institute for
Cancer Research, New York, New York

References and Notes

1. C. F. Benda, *Arch. Pediat.* **73**, 391 (1956); T. H. Ingalls, in *Biology of Mental Health and Disease* (Hoeber, New York, 1952).
2. H. W. Toolan, *Cancer Research* **14**, 660 (1954).
3. — and R. A. Wallace, *Ibid.* **18**, 698 (1958).
4. The abnormality of the hamsters described in this report is physically quite different from the "runting syndrome" described in rats and mice. Baby rats and mice injected with potent fractions developed normally.
5. I am deeply indebted to William Money of the Sloan-Kettering Institute for the 12th studies.
6. The relationship of the abnormality described here for hamsters to that of human mongolism is unknown. An extra autosome has been found in the cells of a number of human mongoloid individuals. It does not seem likely that an extra chromosome exists in the animals described here, although this possibility is being investigated. It appears probable that we have here a phenocopy of the mongoloid entity.
7. This work was aided by grant No. E-109-E10 from the American Cancer Society and was supported in part by Public Health Service grant No. C2042 from the National Cancer Institute, Public Health Service.

24 February 1960

Rapid Induction of Allergic Encephalomyelitis in Rats without the Use of Mycobacteria

Abstract. Rats, in contrast to certain other species of animals reported, have a striking capacity to develop allergic encephalomyelitis within 2 to 3 weeks following one injection of spinal cord antigen combined with Freund's incomplete adjuvant—that is, adjuvant prepared without addition of killed mycobacteria.

The necessity of combining nervous tissue inocula with Freund's complete adjuvant (emulsifying agent, paraffin oil, and killed mycobacteria) for rapid and regular induction of allergic encephalomyelitis (AE) in monkeys and guinea pigs has been reported (1, 2). In these studies, injection of nervous tissue emulsions not containing the mycobacteria induced little, if any, disease. Freund

and Stone (2) have determined the minimal amount of mycobacteria required for induction of characteristic allergic encephalomyelitis in the guinea pig.

Work in our laboratory indicates that mycobacteria are not required for rapid induction of this inflammation in rats. Groups of adult male or female Wistar rats, obtained from two commercial sources, were injected intracutaneously with guinea pig spinal cord (collected aseptically and stored at -20°C for 1 to 7 days) homogenate combined with either complete adjuvant (that is, with added mycobacteria) or incomplete adjuvant (without added mycobacteria) prepared as described by Freund (3). Each rat received approximately 115 mg (wet wt.) of spinal cord (an excessive dose used in past work with this host) in 0.7 ml of inoculum distributed among six sites over the upper dorsum and one site on the ventral neck. The animals were given free access to food pellets and water. They were observed daily for neurological signs for 21 to 26 days following injection; then they were killed and their brains and spinal cords were removed for histological studies. A minimum of seven different hematoxylin and eosin stained sections (at levels of thalamus, mesencephalon, cerebellum, pons, medulla, and cervical-thoracic spinal cord) of nervous tissue from each rat were examined microscopically for lesions.

The results of two representative experiments are shown in Table 1. Twenty-four rats received either of two spinal cord homogenates combined with incomplete adjuvant. Nine rats exhibited moderate to severe flaccid paralysis of the hind legs within 14 to 20 days. Numerous and intense lesions were found in these 9 animals as well as in 13 of the remaining 15 rats. As expected, 6 of the 11 control rats which received spinal cord homogenate combined with complete adjuvant developed allergic encephalomyelitis. The data (Table 1) are in agreement with the results of three other experiments, not given in detail here. Additional control rats, which were similarly injected with guinea pig kidney homogenate and incomplete adjuvant or with only the adjuvant, remained clinically well and

were subsequently found to have no lesions.

It is of interest that allergic encephalomyelitis may be induced in rats by an intracutaneous injection of the spinal cord antigen alone. For example, 2 of 16 rats used in two experiments were found to have lesions when sacrificed approximately 3 to 4 weeks postinjection. This finding is not unexpected in view of studies of earlier workers (4) showing that this inflammation or its equivalent may occasionally be induced in rats, rabbits, and monkeys by often-repeated injections of nervous tissue homogenates or extracts. More recently, Morrison (5), Jervis *et al.* (6), and Waksman (7) have reported that encephalomyelitis occasionally may be induced in rabbits, dogs, and mice after one to several injections of nervous tissue not combined with Freund's adjuvant.

The data (Table 1) indicate that in the rat, emulsifying agent-paraffin oil, without addition of mycobacteria, provides the necessary adjuvant effect for rapid, regular induction of the inflammation. The work reported here has direct bearing on studies of the mode of action of Freund type immunological adjuvants with respect to their capacity to enhance immune responses, of the immediate or the delayed type or both, against a wide variety of antigenic materials, including nervous tissue antigens (8).

JENNIFER BELL
PHILIP Y. PATERSON

Department of Microbiology, New York University College of Medicine, New York, and National Institute of Allergy and Infectious Diseases, Bethesda, Maryland

References and Notes

1. I. M. Morgan, *J. Exptl. Med.* **85**, 131 (1947); E. A. Kabat, A. Wolf, A. E. Bezer, *Ibid.* **85**, 117 (1947); J. Freund, E. R. Stern, T. M. Pisani, *J. Immunol.* **87**, 179 (1947).
2. J. Freund and S. H. Stone, *J. Immunol.* **82**, 560 (1959).
3. J. Freund, in *Advances in Tuberc. Research* **7**, 130 (1956).
4. R. Koritschoner and F. Schweinburg, *Z. Immunitätsforsch.* **42**, 217 (1925); Y. Miyagawa and S. Ishii, *Sci. Repts. Govt. Inst. Infectious Diseases Tokyo Imp. Univ.* **5**, 331 (1926); T. M. Rivers, D. H. Sprunt, G. P. Berry, *J. Exptl. Med.* **58**, 39 (1933); T. M. Rivers and F. F. Schwenker, *Ibid.* **61**, 689 (1935); F. F. Schwenker and T. M. Rivers, *Ibid.* **60**, 559 (1934).
5. L. R. Morrison, *A.M.A. Arch. Neurol. Psychiat.* **58**, 391 (1947).
6. G. A. Jervis, R. L. Burkhardt, H. Koprowski, *Am. J. Hyg.* **50**, 14 (1949); G. A. Jervis and H. Koprowski, *Can. J. Comp. Med. Vet. Sci.* **13**, 116 (1949).
7. B. H. Waksman, *J. Infectious Diseases* **99**, 258 (1956).
8. The interest of Dr. Jules Freund in this study and his suggestions concerning preparation of the manuscript are appreciated. The technical assistance of Mr. Norman C. Didakow was invaluable throughout the work. Part of the work by one of us (J.B.) was supported by a National Foundation fellowship.

7 March 1960

Table 1. Allergic encephalomyelitis (AE) in rats following an intracutaneous injection of spinal cord combined with Freund's immunological adjuvants.

Expt. No.	Spinal cord antigen	Paraffin oil and emulsifying agent	Killed mycobacteria	No. with signs and lesions of AE	No. with lesions of AE only	Total No. injected
E 7-58	+	+	0	3	9	12
	+	+	+	3	0	6
G11-58	+	+	0	6	4	12
	+	+	+	2	1	5

Induced Phenotypic Resistance to an Antimetabolite

Abstract. Resistance to bacteriostasis by 2-thiazole alanine develops rapidly; however, such resistance is lost during growth in the absence of the analog. This induced resistance is accompanied by increased formation of an enzyme sensitive to 2-thiazole alanine. Maintenance of the elevated enzyme levels in growing cells, like resistance, requires the presence of the analog.

An antimetabolite, 2-thiazole alanine, has been shown to retard the growth of *Escherichia coli* W by mimicking the specific inhibitory effect of its corresponding metabolite, histidine, on the action of "compound III" synthetase, an early enzyme of histidine biosynthesis (1). Further investigation reveals that this false feedback inhibitor has an immediate but transitory bacteriostatic effect; after a brief period, growth is resumed at an exponential rate somewhat lower than usual. Both the duration of bacteriostasis and the extent of the reduction in the rate of the subsequent growth increase with increasing concentration of the analog.

It is extremely unlikely that the temporary nature of the bacteriostasis is due to selection of resistant mutants, for resumption of growth occurs after

relatively brief periods (up to 1 hour). Destruction of the analog also appeared to be an unlikely explanation, for the bacteriostatic action of 2-thiazole alanine lasts for a much shorter period than its inhibitory effect on the excretion of histidinol by nongrowing cells of a mutant which cannot convert this intermediate to histidine. This conclusion is also supported by the results shown in Fig. 1. Cells which have recovered from the initial inhibition by 2-thiazole alanine grow without a lag when transferred to fresh media containing the inhibitor; however, if the cells are allowed to grow sufficiently in normal media before re-exposure to the antimetabolite, the initial sensitivity of the strain is again observed. 2-Thiazole alanine thus appears to be an inducer of resistance to its bacteriostatic action.

An explanation for this apparent paradox was suggested by assuming that both the inhibition of growth and the subsequent induction of resistance are consequences of a single activity of 2-thiazole alanine: inhibition of the synthesis of the histidine precursor, "compound III." The resulting decrease in the intracellular supply of histidine would decrease the growth rate, but it would also relieve the repressive effect of histidine on the formation of "compound III" synthetase (2) so that an increased amount of this enzyme system, which is sensitive to 2-thiazole alanine, might be formed (3). In this manner "compound III" synthesis could be resumed despite the presence of 2-thiazole alanine.

This explanation is supported by observations on the cellular content of "compound III" synthetase. Growth in a medium containing a small amount of the antimetabolite caused a three-fold increase in the specific activity of the enzyme in extracts of the cells. Maintenance of the elevated activity in growing cells was dependent on the continued presence of 2-thiazole alanine (Fig. 2). Increasing the levels of the analog in growing cultures causes parallel increases in the level of the enzyme within the cell, up to 20 times the normal.

This response to 2-thiazole alanine bears a formal resemblance to induced enzyme formation. The analog permits induction of "compound III" synthetase by inhibiting the synthesis of histidine, which would normally prevent extensive formation of this enzyme system. While these observations may not be relevant to the action of the usual inducers of enzyme formation, it is interesting to note the re-

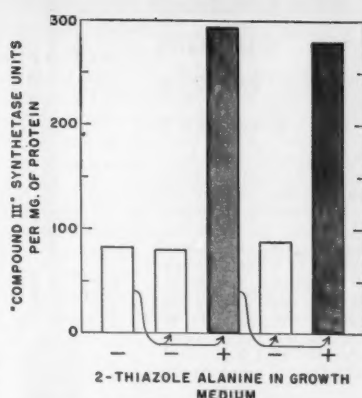


Fig. 2. Induction of "compound III" synthetase formation by 2-thiazole alanine. A unit of "compound III" synthetase activity corresponds to the formation of 0.4 μ mole of the compound per hour. Enzymatic activity was determined by the method of Moyed and Magasanik (2). The cells were grown in the medium described in Fig. 1 and were harvested while still in the exponential phase of growth. Extracts were prepared by sonic oscillation. The original inoculum was a 16-hour culture of *Escherichia coli* W in minimal medium. The subsequent transfers are indicated by arrows. After each transfer the cultures were incubated until a 15-fold increase in cell mass had occurred.

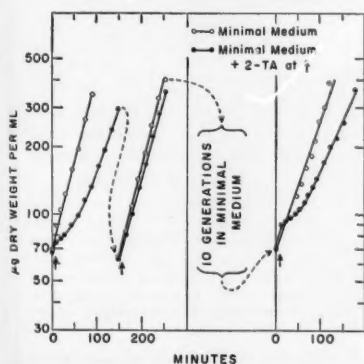


Fig. 1. Induction of resistance to the bacteriostatic action of 2-thiazole alanine (2-TA). The inoculum was an exponentially growing culture of *Escherichia coli* W. The minimal medium contained, per liter: 18.9 gm of $\text{Na}_2\text{HPO}_4 \cdot 7\text{H}_2\text{O}$, 6.3 gm of KH_2PO_4 , 0.2 gm of $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, 0.01 gm of CaCl_2 , 2 gm of $(\text{NH}_4)_2\text{SO}_4$, 2 gm of glucose, and 2 mg of 2-thiazole alanine as indicated. The cultures were aerated by rotary shaking at 37°C. The arrows indicate the transfers made during the experiment. Growth was measured as change in optical density and is expressed as micrograms of dry weight of bacteria per milliliter from a previous calibration.

cent evidence that at least one inducer functions by antagonizing an unknown but specific repressor of enzyme formation (4).

Similar responses by bacterial and mammalian cells to other enzyme inhibitors could be important factors in the failure of many theoretically useful compounds to inhibit cell growth effectively at low doses (5).

H. S. MOYED

Department of Bacteriology and Immunology, Harvard Medical School, Boston, Massachusetts

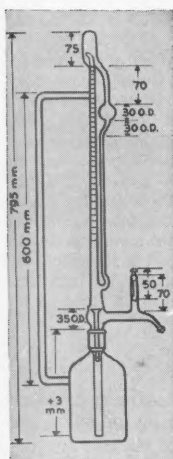
References and Notes

1. H. S. Moyed and M. Friedman, *Science* **129**, 968 (1959); *Federation Proc.* **18**, 290 (1959).
2. H. S. Moyed and B. Magasanik, *J. Biol. Chem.* **235**, 149 (1960).
3. Such a stimulation of the production of "compound III" synthetase was observed when the intracellular level of histidine was depleted by another technique in which a histidine auxotroph is forced to obtain the amino acid at a low rate from β -alanine. The use of a combined form of histidine for this purpose was suggested by B. N. Ames and B. Garry, *Proc. Natl. Acad. Sci. U.S.A.* **45**, 1453 (1959).
4. A. B. Pardee, F. Jacob, J. Monod, *J. Molecular Biol.* **1**, 165 (1959).
5. This work was supported by U.S. Public Health Service grant RG-6059. The 2-thiazole alanine was donated by R. G. Jones of the Lilly Research Laboratories.

28 December 1959

We catalog custom burets like this

This automatic buret happens to be item 90850 in the Corning catalog of PYREX Brand Laboratory Glassware (a very big catalog, as you may know). It meets Bureau of Standards tolerances for accuracy. You can get four sizes: 10, 25, 50 and 100 ml; bottles have capacities of 1,000, 2,000 and 4,000 ml, respectively.



Modify them on request

One of the largest and best aggregations of lamp workers and builders of glass gadgetry serves our Special Apparatus customers. They'll gladly perform such simple modifications as addition of extra necks, built-in drying tubes, or additions of thermometer wells.

A lot as well as a little

In case your request approaches the bizarre, we can even make major modifications such as triple bottles with double necks and a side-arm or two. To glassworkers as skilled as ours (and as well-equipped), no suggestions could be too fanciful or too difficult. And, incidentally, we can make a real production of these "specials." Turn them out by the hundreds. Try us. If you don't already have a copy of our catalog, LG-1, on hand, ask for it.



Special Apparatus Section



CORNING GLASS WORKS

34 Crystal Street, Corning, N.Y.
CORNING MEANS RESEARCH IN GLASS

1450

Meetings

Science in Nigeria

The second annual conference of the Science Association of Nigeria was held in Zaria, Northern Nigeria, 15 to 18 December 1959. This association, affiliated with the wider organization of the West African Science Association, has been in existence only 1 year. Its membership is recruited from all branches of the teaching profession, from government scientists, and from industrial organizations.

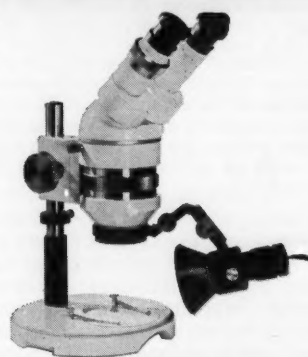
The immense developments in Nigeria since World War II have given rise to a large increase in the numbers of scientific workers, both African and European. Yet the over-all numbers are still grossly inadequate for the country's need in an age of technological expansion. The association was brought into being for the dual purpose of providing a forum for scientists working in the country and of informing the general public of the role which scientific work is playing in their lives. Already the association has achieved considerable success. The quality of the papers and the discussions at the 1959 meeting was extremely high and gave a picture of a general standard of work and achievement which would have been unthinkable not many years ago.

The most obvious immediate technological needs of this country are in agriculture and allied fields. It is not surprising, therefore, that a great deal of emphasis was placed on agricultural developments and on the relation of these developments to nutrition. But other subjects were not neglected. The disturbing question of the biological effects of radiation—a real issue in this country since the first mention of atom-bomb tests in the Sahara—was dealt with in a scholarly and authoritative manner. There were brief incursions into the realms of physiology and even of philosophy.

The importance of the meeting, though, really lay in the fact that it brought together workers from many parts of Nigeria and from many fields of work. Physical and intellectual isolation are an ever-present danger in a vast, underdeveloped territory such as this, and an interchange of ideas and viewpoints is a real necessity.

This meeting underlined a phenomenon of great significance, certainly, in Africa, probably also in other territories—namely, a reorientation in the pattern of research. Before the war the tropics, at best, were field stations visited by scientists from Europe who collected their material for examination in properly equipped laboratories in Europe. Today, Nigeria has not merely

STEREO- MICROSCOPE



IMMEDIATE DELIVERY
Long Working Distance
Superb Optics
Magnifications 6X-200X
Large Variety of Accessories
Old World Craftsmanship
ERIC SOBOTKA CO.

108 West 40th St.
New York, 18, N. Y.

Specialists in Imported Equipment

GRASSLANDS

Editor: Howard B. Sprague 1959

6" x 9", 424 pp., 37 illus., index, cloth.
Price \$9.00, AAAS members' cash orders \$8.00. AAAS Symposium Volume No. 53.

This volume is intended as a review of knowledge on many aspects of grasslands resources. The 44 authors were selected by their own professional colleagues as being particularly competent to present the respective subjects. Thirty-seven papers are arranged under these chapter headings:

1. Sciences in Support of Grassland Research
2. Forage Production in Temperate Humid Regions
3. Engineering Aspects of Grassland Agriculture
4. Forage Utilization and Related Animal Nutrition Problems
5. Evaluation of the Nutritive Significance of Forages
6. Grassland Climatology
7. Ecology of Grasslands
8. Range Management

British Agents: Bailey Bros. & Swinfen, Ltd.,
Hyde House, W. Central Street,
London, W.C.1

**AAAS, 1515 Mass. Ave., NW,
Washington 5, D.C.**

MISSILE-KILLER 20th CENTURY

Over White Sands, New Mexico, a killer searched the skies for its target — and found it. With deadly accuracy Raytheon's HAWK missile delivered a lethal blow to another supersonic missile in flight.

Development of Army's HAWK "killing power" by Raytheon's Missile Systems Division, made possible this *first successful interception* of one missile by another. And today, as a vital part of one of the world's largest electronics companies, Raytheon continues to make significant contributions to the art of missilery. The exciting new Pin Cushion Project for the selective missile identification and the continually being improved Navy's air-to-air SPARROW III are examples of their outstanding creative work.

We are now seeking talented, qualified people to maintain Raytheon's leadership in this challenging field. Raytheon's Missile Systems Division creates a climate for talent — perhaps *your* talent.



ENGINEERS: Immediate openings in Operations Analysis • Radar Systems • Data Processing • Design Data • Systems Test • Specification Engineering • Circuit Design • Systems Analysis • Electronic Packaging • Transmitter Design • Process Engineering • Product Engineering • Publications • Quality Control • Microwave.

Your resumé will receive prompt attention. Please address it to: Mr. Richard S. Malcolm, Coordinator of Employment/Placement, Missile Systems Division, Raytheon Company, 520 Winter Street, Waltham, Massachusetts.

18WS



**MISSILE
SYSTEMS
DIVISION**

... creates a climate for talent.

CHROMATOGRAPHY DRYING OVEN

Full View, Compact Table Model for Fast, Uniform Drying of Paper Chromatograms

Accurately Develops four 18 1/4" x 22 1/2" sheets simultaneously



Model CO-4 is a thermostatically controlled, insulated oven which quickly reaches temperatures up to 100° C. Achieves evacuation of solvent vapors with water or motor aspirator. Heating elements concealed in base are protected from combustible, solvent droplets. Heavy, metal-reinforced, safety glass door readily permits observation of color development without repeated opening of door. Stainless steel oven chamber is corrosion-resistant.

Overall Dimensions: 27" wide; 37" high; 15 1/2" deep

UNCONDITIONAL 1 YEAR WARRANTY

Write for Catalog CD-513S



NEW BRUNSWICK SCIENTIFIC CO., INC.

PRECISION LABORATORY APPARATUS

P.O. BOX 606, NEW BRUNSWICK, NEW JERSEY

REHABILITATION OF THE MENTALLY ILL

Social and Economic Aspects

A symposium of the American Psychiatric Association, cosponsored by the AAAS Section on Social and Economic Sciences and the American Sociological Society.

Edited by Milton Greenblatt and Benjamin Simon

This volume presents an up-to-date picture of rehabilitation in its broadest sense. The contributions are from outstanding researchers and practitioners in the field. The process of rehabilitation is examined from the standpoint of (a) hospital, (b) transitional aspects, and (c) community. The rehabilitation of the individual in the total sense is seen as a continuum starting from the moment of admission to his final resettlement in the community and many techniques and recommendations for improved patient care and treatment are contained in the book.

December 1959, 260 pp., \$5.00
AAAS Members' Cash Orders \$4.50

English Agents: Bailey Bros. & Swinfen, Ltd.
Hyde House, West Central Street
London W.C.1, England

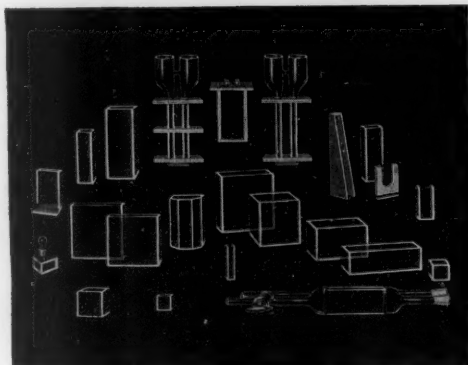
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

1515 Massachusetts Avenue, NW
Washington 5, D.C.

GLASS ABSORPTION CELLS

made by

KLETT

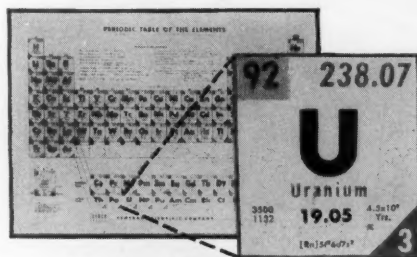


SCIENTIFIC APPARATUS

Klett-Summerson Photoelectric Colorimeters—
Colorimeters—Nephelometers—Fluorimeters—
Bio-Colorimeters—Comparators—Glass Stand-
ards—Klett Reagents.

Klett Manufacturing Co.

179 East 87 Street, New York, New York



←This unit is 1/6 actual size

Another NEW

LECTURE ROOM PERIODIC TABLE

LARGER • EASY TO READ • COLORFUL
INCLUDES ATOMIC DATA

Includes all elements and number of naturally occurring radioactive and stable isotopes. Shows atomic number in large type, also weight, density, boiling and melting points, electronic configuration, half-life, and important atomic constants for physics and chemistry. New large lecture room size, 62" x 52", in 4-colors on heavy plastic coated stock.

No. 12056 with wood strips and eyelets.....each \$ 7.50
No. 12057 mounted on spring roller with brackets.... \$12.50



CENTRAL SCIENTIFIC CO.

A Subsidiary of Cenco Instruments Corporation
1718-N Irving Park Road • Chicago 13, Ill.
Branches and Warehouses—Mountainside, N. J.
Boston • Birmingham • Santa Clara • Los Angeles • Tulsa
Houston • Toronto • Montreal • Vancouver • Ottawa

the laboratories (insufficient in number, perhaps, but still there) but also the scientific personnel to carry out the work. The opportunities here are immense, and the challenge is something which Europe cannot match. There is, after all, a fundamental absurdity (though this was justifiably overlooked at the time they were created) in situating institutions of tropical research in England or indeed anywhere outside the tropics. This change alone is a big development. Most of the original work carried out in this country is, perforce, in applications such as agriculture and medicine. Nevertheless, the third step toward scientific maturity has already been taken, for there is now a great deal of "pure" research going on, particularly at the University College, Ibadan.

Science and technology in Nigeria are still young, but one feels that the plant is viable, that scientific activity will continue to grow, and that the nation as a whole will increasingly come to accept the new technologies as her best guarantee of future prosperity.

These are the impressions gleaned at the conference, at least by one observer. I feel that the Science Association of Nigeria is to be congratulated on the success of its first year of life and, in particular, of its second conference.

BRIAN HOPKINS

University College, Ibadan, Nigeria

Forthcoming Events

June

8-10. Canadian Federation of Biological Societies (Canadian Physiological Soc., Pharmacological Soc. of Canada, Canadian Assoc. of Anatomists, Canadian Biochemical Soc.), 3rd annual, Winnipeg, Manitoba. (E. H. Bensley, Montreal General Hospital, 1650 Cedar Ave., Montreal 25, P.Q.)

8-11. National Soc. of Professional Engineers, annual, Boston, Mass. (P. H. Robbins, NSPE, 2029 K St., NW, Washington 6)

8-12. American College of Chest Physicians, Miami Beach, Fla. (M. Kornfeld, 112 E. Chestnut St., Chicago 11, Ill.)

9-10. American Geriatrics Soc., Miami Beach, Fla. (R. J. Kraemer, 2907 Post Rd., Warwick, R.I.)

9-10. Canadian Inst. of Food Technology, 3rd annual conf., Winnipeg, Manitoba. (W. J. Eva, Box 846, Winnipeg, Manitoba)

9-10. Society of Women Engineers, 10th annual conv., Seattle, Wash. (Mrs. J. A. Troxell, 3613 E. 43 St., Seattle 5)

9-11. Acoustical Soc. of America, Providence, R.I. (W. Waterfall, ASA, 335 E. 45 St., New York 17)

9-11. Endocrine Soc., Miami Beach, Fla. (H. H. Turner, 1200 N. Walker, Oklahoma City 3, Okla.)

9-11. National Speleological Soc., annual, Carlsbad, N.M. (G. W. Moore, U.S. Geological Survey, Menlo Park, Calif.)

NEW!

Bausch & Lomb SPECTRONIC 505* Recording Spectrophotometer



*...less than half
the cost of other
recording
spectrophotometers!*

\$3685 VISIBLE RANGE
(UV-VISIBLE, \$4285)

See the revolutionary new instrument that directly records transmittance, absorbance, reflectance and emission in UV and visible ranges...

with an exclusive electronic sensor that automatically adjusts drum speed to variations in curve complexity... featuring B&L Certified-Precision Gratings.

Only 36" x 22" x 15", it's as streamlined as the universally accepted B&L Spectronic 20* Colorimeter...

with a complete line of accessories including an exclusive new air-cooled Hydrogen lamp...

at less than half the cost of other recording spectrophotometers.

*Trademark, Bausch & Lomb

WRITE for your copy of Catalog D-2009,
Bausch & Lomb, 75905 Bausch Street,
Rochester 2, N. Y.



EPIDEMIOLOGY OF MENTAL DISORDER

AAAS Symposium
Volume No. 60

Edited by Benjamin Pasamanick

A symposium organized by the American Psychiatric Association to commemorate the centennial of the birth of Emil Kraepelin; cosponsored by the American Public Health Association.

... pioneering interdisciplinary studies by investigators from biostatistics, genetics, obstetrics, pediatrics, psychiatry, psychology, public health and sociology.

December 1959, 306 pp., \$6.50
AAAS members' cash orders, \$5.75

English Agents: Bailey Bros. & Swinfen, Ltd.
West Central Street
London W.C.1, England

**American Association
for the Advancement of
Science**

1515 Massachusetts Ave., NW
Washington 5, D.C.

HERE'S A QUALITY STUDENT MICROSCOPE AT A BUDGET PRICE!

Although budget priced, the UNITRON Model MUS is definitely not just another student microscope. It includes these significant features often lacking in much more costly student models:

- NOT JUST a disk diaphragm... but an iris diaphragm for perfect control of aperture.
- NOT JUST a single focusing control... but both coarse and fine.
- NOT JUST a mirror... but a condenser for optimum illumination and resolution.
- NOT JUST one objective... but three: SX, 10X, 40X.
- NOT JUST one eyepiece... but a choice of two from SX, 10X, 15X.

Durable, sturdy — ideally suited to withstand the use and abuse of classroom and laboratory.

5 — 10
UNITS **\$66.60**
F. O. B. Destination



ASK FOR A FREE 10 DAY TRIAL.

Quantity discounts start at 2 — only \$65.12 for 11 — 24 units

UNITRON

INSTRUMENT DIVISION of UNITED SCIENTIFIC CO.
204-206 MILK STREET • BOSTON 9, MASS.

Please rush UNITRON's Microscope Catalog 40-C

Name _____
Company _____
Address _____
City _____ State _____

9-12. American Medical Women's Assoc., Miami Beach, Fla. (Mrs. L. T. Majally, 1790 Broadway, New York 19)

9-12. American Rheumatism Assoc., annual, Hollywood-by-the-Sea, Fla. (F. E. Demartini, Presbyterian Hospital, 622 W. 168 St., New York 32)

9-12. American Therapeutic Soc., Miami Beach, Fla. (O. B. Hunter, Jr., 915 19 St., NW, Washington 6)

10-12. American College of Angiology, Miami Beach, Fla. (A. Halpern, 11 Hampton Court, Great Neck, N.Y.)

10-12. American Electroencephalographic Soc., Boston, Mass. (G. A. Ulett, 1420 Gratten St., St. Louis 4, Mo.)

10-12. Society for Biological Psychiatry, Miami Beach, Fla. (G. N. Thompson, 2010 Wilshire Blvd., Los Angeles 57, Calif.)

11. American Acad. of Tuberculosis Physicians, Miami Beach, Fla. (G. P. Bailey, P.O. Box 7011, Denver 6, Colo.)

11-12. American Diabetes Assoc., Miami Beach, Fla. (J. R. Connelly, 1 E. 45 St., New York 17)

11-16. American Soc. of X-ray Technicians, Cincinnati, Ohio. (G. J. Eilert, 16 Fourteenth St., Fond du Lac, Wis.)

12. Society for Vascular Surgery, Miami Beach, Fla. (G. H. Yeager, 314 Medical Arts Bldg., Baltimore 1, Md.)

12-15. American Nuclear Soc., 6th annual, Chicago, Ill. (O. Du Temple, ANS, c/o John Crerar Library, 86 E. Randolph St., Chicago 1)

12-15. American Soc. of Agricultural Engineers, Columbus, Ohio. (J. L. Butt, P.O. Box 229, St. Joseph, Mich.)

12-16. Cancer Research, 4th Canadian conf., Honey Harbour Ontario, Canada. (R. L. Noble, Collip Research Laboratory, Univ. of Western Ontario, London, Ontario, Canada)

12-17. Association for Research in Ophthalmology, Miami Beach, Fla. (L. V. Johnson, 10515 Carnegie Ave., Cleveland)

13-14. Technical Writing Improvement Soc., 5th Southern Calif. Industrial Writing Inst., Los Angeles, Calif. (J. L. Kent, TWIS, P.O. Box 5453, Pasadena, Calif.)

13-15. American Neurological Assoc., Boston, Mass. (M. D. Yohr, 710 W. 168 St., New York 32)

13-15. American Soc. of Heating, Refrigerating and Air-Conditioning Engineers, 67th annual, Vancouver, B.C. (E. R. Searles, ASHRAE Journal, 234 Fifth Ave., New York 1)

13-15. Chemical Inst. of Canada, 43rd conf., Ottawa, Ontario. (CIC, 48 Rideau St., Ottawa 2, Ontario)

13-15. Herpetologists League, Eugene, Ore. (A. M. Woodbury, 248 University St., Univ. of Utah, Salt Lake City 2)

13-15. International Powder Metallurgy Conf., New York, N.Y. (K. H. Roll, Metal Powder Industries Federation, 60 E. 42 St., New York 17)

13-15. Microscopy, natl. symp., Chicago, Ill. (Walter C. McCrone Associates, 501 E. 32 St., Chicago 16)

13-15. Society for Investigative Dermatology, 21st annual, Miami Beach, Fla. (H. Beerman, SID, 255 S. 17 St., Philadelphia)

13-17. American Medical Assoc., Miami Beach, Fla. (F. J. L. Blasingame, 535 N. Dearborn St., Chicago 10, Ill.)

(See issue of 22 April for comprehensive list)

New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither Science nor the writer assumes responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to the manufacturer. Include the department number in your inquiry.

■ **DISPLACEMENT TRANSDUCER** uses a lift bar actuated by the motion being measured. As the lift bar rises in response to the mechanical input, successive contact pairs close and sequentially short circuit an increasing fraction of the total resistance of the device. Full-scale displacement is $\frac{1}{8}$ in. A dither coil serves to smooth the transfer characteristics and to reduce the actuation force to 10 gm. A 20-contact model will dissipate up to 200 watts and directly control circuits in the low kilowatt range. (Electric Regulator Corp., Dept. Sci499, Pearl St., Norwalk, Conn.)

■ **PHASE DETECTOR** for the frequency range 15 to 400 Mc/sec claims accuracy of ± 0.05 deg or ± 1 percent of dial reading. The smallest phase angle that can be read is less than $10^{-13} \times 360 \times$ frequency (in cy/sec). The minimum input signal depends on the sensitivity of the receiver used and is approximately $20 \mu\text{V}$ for a receiver of $5 \mu\text{V}$ sensitivity. A 2-volt minimum signal is recommended by the manufacturer if the instrument's panel meter is used as the indicator. (Ad-Yu Electronics, Inc., Dept. Sci501, 249-259 Terhune Ave., Passaic, N.J.)

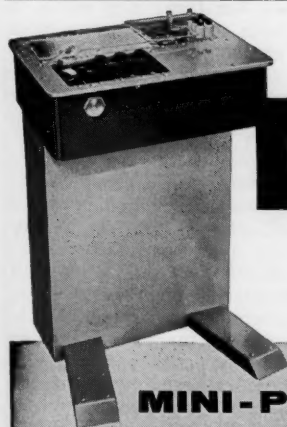
■ **PROTECTIVE SUIT SYSTEM** isolates a worker from toxic or corrosive elements in the environment through complete enclosure in sealed coveralls. The air volume within the suit is recirculated and processed to remove heat, water vapor, and carbon dioxide, while oxygen is added at the rate of consumption. The air-reconditioning device, completely self-contained and worn under the coveralls, weighs less than 15 lbs. It is suitable for 1 hour of active use and is easily renewed. (Isolair, Environment Incorporated, Dept. Sci503, Box 51, Yellow Springs, Ohio.)

■ **DISTANCE MEASURING INSTRUMENT** of the capacitance-probe type covers the range to 0.5 in. in four ranges with four probes. Accuracy is said to be ± 2 percent of full-scale deflection, discrimination better than ± 0.5 percent. The instrument is direct-reading, with display provided by a moving-coil meter. Standard probes designed for measurement of flat conducting surfaces have plane circular electrodes with guard-ring construction. Special probes for curved surfaces can be supplied. An output signal for operation of recorders or other auxiliary equipment furnishes

A new publishing firm
invites
the submission
of manuscripts
by professionals
of standing in their fields.

* *
Manuscripts accepted
in May and June
will be prepared for publication
before Christmas, 1960.

* *
PAUL MARTINEAU, Publisher
Box 421 Ithaca, N.Y.



GME's

New

MINI-POLYGRAPH

"Simplicity and accuracy for student or scientist"

- Compact versatility — EEG, ECG, and 2 pressure channels or ECG and 3 pressure channels
- Transducers plug in directly — no extra power supply or pre-amplifiers needed
- Rugged and sturdy
- Plug-in printed circuits
- Rectilinear recording with ink on 6" paper with millimeter square marking; simple and reliable linkage — only two moving parts
- Anti-clogging inking system
- Instantaneous speed change — 6 speeds

GILSON MEDICAL ELECTRONICS
On Madison's West Beltline Highway
Middleton, Wisconsin

WARING'S EXPLOSION - PROOF BLENDOR® BASE FOR USE IN ALL HAZARDOUS LOCATIONS*



MODEL EP-1

Introduced recently, Waring's new Explosion-Proof Blendor Base already has been recognized by safety committees throughout the country as the answer to safely blending materials at high speed wherever hazardous atmospheres exist. *Exposed motor arcing is completely eliminated.* Even the most critical blending operations may now be performed with safety in areas that are permeated with flammable gases or vapors likely to produce explosive or ignitable mixtures. No wonder this exclusive Waring Explosion-Proof Blendor Base has had wide, enthusiastic acceptance in the chemical, petroleum and other industries!

SPECIFICATIONS: Lifetime-lubricated motor is wired for 2 speeds; 1/2 H.P.; 120 volts; AC-DC; 25-60 cycles; 4.2 amps. Stainless steel container (shown) or Pyrex container, both with 37 1/2-ounce capacity, may be used.

*Class I—Group D Rating

WARING PRODUCTS CORPORATION

25 West 43rd Street, New York 36, N. Y.

A subsidiary of Dynamics Corporation of America

NAME YOUR BLENDING PROBLEM

Waring Engineers will help you solve it.

SEND FOR FREE LITERATURE

GENTLEMEN:

I want full specification data on the new Explosion-Proof Waring Laboratory Blendor Base.

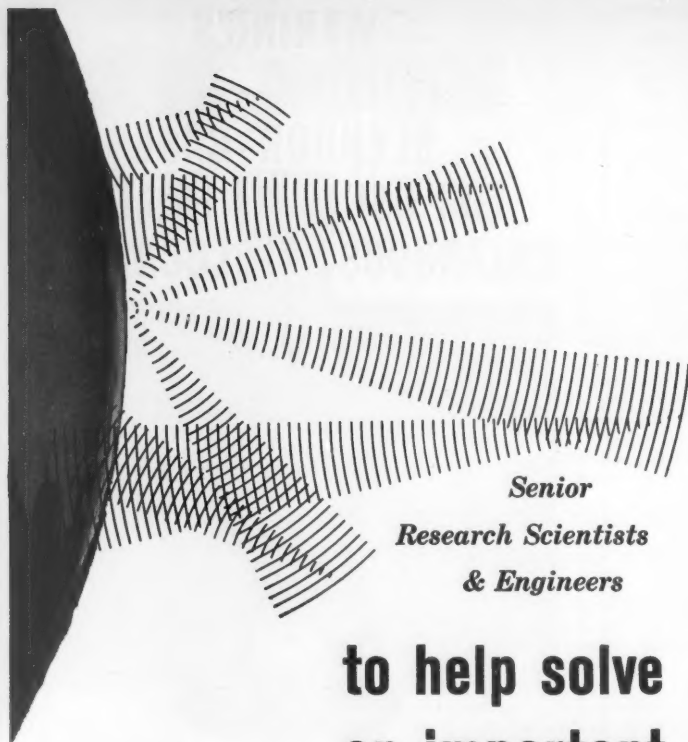
NAME.....

TITLE.....

COMPANY.....

ADDRESS.....

CITY /ZONE.....STATE.....



**Senior
Research Scientists
& Engineers**

to help solve an important communications problem

The problem... to define the parameters and establish feasibility of a long-range, ECM-proof, single or multiple path communications system capable of negligible degradation and an ultra-high degree of reliability while operating in a constantly changing environment.

The solution, at present, is difficult... all known techniques, individually or multi-plexed, would provide only marginal performance.

Research Scientists and Engineers with advanced degrees who feel they can contribute new insight, new concepts, and the application of new techniques to the establishment of this vitally important system are invited to forward their confidential inquiry to:

Dr. R. L. San Soucie

Amherst Laboratory / SYLVANIA ELECTRONIC SYSTEMS
A Division of

SYLVANIA
Subsidiary of GENERAL TELEPHONE & ELECTRONICS

1146 Wehrle Drive—Williamsville 21, New York

a current of 0 to 1 ma into resistance up to 1000 ohm. Another output, for oscilloscope display, is an amplitude-modulated 50 kcy/sec signal; full-scale is 7 volts r.m.s. (Wayne Kerr Corp. Dept. Sci512, 1633 Race St., Philadelphia 3, Pa.)

■ **PULSE HEIGHT ANALYZER** employs a stepping motor that advances the threshold setting in discrete 1-volt increments. A scaler records the counts at each setting and after the expiration of preset count or preset time a data printer records the channel number, count and elapsed time on a paper tape. Up to 100 channels may be counted. An adjustable, overriding preset time prevents excessively long time scan when the analyzer is operating on preset count. The instrument is available with or without a stabilized 2000-volt power supply. (Tracerlab/Keleket, Dept. Sci-513, 1601 Trapelo Rd., Waltham 54, Mass.)

■ **INSULATION TESTER** automatically checks insulation leakage current, making sequential tests of up to 50 components on circuits for periods to 12 hr without requiring adjustment or other attention. Test potential may be set for any value to 50 kv. Rate of rise and duration of the test potential, up to 15 min, are adjustable. Reject-current controls are adjustable from 0.5 μ a to 250 ma. The tester may be set to shut off upon locating a defect or to continue checking but dropping to zero the test potential on the unit that has failed. (Associated Research, Inc., Dept. Sci508, 3777 W. Belmont Ave., Chicago 18, Ill.)

■ **OPTICAL-PYROMETER CALIBRATION SET** permits simultaneous calibration of two pyrometers. The set provides a wide filament-strip type lamp that can be adjusted by step and vernier rheostats to temperatures in the range 800° to 2300°C. Instrument holders and brackets are furnished to permit mounting different types of optical pyrometers. A certificate of calibration is furnished with the set. (Pyrometer Instrument Co., Dept. Sci518, Bergenfield, N.J.)

■ **VACUUM HOLDING TOOL** is designed to pick up and handle delicate parts for inspection or positioning operations. A wide range of plastic tips is available to meet the requirements of specific operations. Associated with the tool is a device, operated by compressed air, to provide vacuum where a standard compressed-air line is available. (Air-Vac Engineering Co., Dept. Sci523, Old Stratford Rd., P.O. Box 27, Shelton, Conn.)

JOSHUA STERN
National Bureau of Standards,
Washington, D.C.

Volume 11 (May 1960)

ANNUAL REVIEW OF MEDICINE

Virus Diseases: Some Aspects of Host and Tissue Specificity
 Infectious Diseases: Bacterial
 Gastrointestinal Diseases: Portal Hypertension
 Gastrointestinal Diseases: Hepatic Coma
 Cardiovascular Disease: Arterial Hypertension
 Cardiovascular Disease: Pulmonary Hypertension
 Cardiovascular Disease: Perinatal Circulation
 Diseases of the Kidney: Acute Renal Failure
 Surgical Diseases of the Kidney
 Hematology: The Megaloblastic Anemias
 Hematology: Control of Red Cell Production
 Nutrition and Nutritional Diseases
 Endocrinology: The Thyroid
 Allergy and Immunology: The L.E. Cell Phenomenon
 Allergy and Immunology: Delayed Hypersensitivity and Homografting
 Neoplastic Diseases: Hormone-producing or Hormone-dependent Tumors
 Psychiatry: Behavioral Problems in the Adolescent
 Special Therapeutics: Physiology of Diuretics
 Radiology: Reaction to Short-term Radiation in Man
 Radiology: High Voltage Radiation Therapy
 Dermatology: Hormonal Control of Pigmentation
 Dermatology: Biochemical Changes in the Dermatitis
 Pediatrics: Congenital Enzyme Defects
 \$7.00 postpaid (U.S.A.); \$7.50 postpaid (elsewhere)

ANNUAL REVIEWS, INC.
 Grant Avenue, Palo Alto, California

MULTIPLE-REFLECTION GALVANOMETER FOR LABORATORY AND PLANT



A self-contained spotlight galvanometer of extreme sensitivity for the indication of minute D. C. currents and voltages.

model
45

- Bright light spot, sharp hairline index, tilted scale
- Scales for null indication and deflection readings
- Single knob wide-range zero-adjustment
- All metal construction, dust-protected, shock-mounted

Write for descriptive Bulletin #965 to

PHOTOVOLT CORP.

95 MADISON AVENUE • NEW YORK 16, N. Y.

Also: Colorimeters, Fluorescence Meters, Recorders, pH Meters

PERSONNEL PLACEMENT

CLASSIFIED: Positions Wanted, 25¢ per word, minimum charge \$4. Use of Box Number counts as 10 additional words. Payment in advance is required. Positions Open, \$40 per inch or fraction thereof. No charge for box number.

COPY: For classified ads must reach SCIENCE 2 weeks before date of issue (Friday of every week).

DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

Single insertion	\$40.00 per inch
4 times in 1 year	38.00 per inch
7 times in 1 year	36.00 per inch
13 times in 1 year	34.00 per inch
26 times in 1 year	32.00 per inch
52 times in 1 year	32.00 per inch

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

Replies to blind ads should be addressed as follows:
 Box (give number)
 Science
 1515 Massachusetts Ave., NW
 Washington 5, D.C.

POSITIONS WANTED

Biologist, Ph.D., 5 years of teaching, 5 years of research, cellular, comparative physiology, biochemistry, wishes academic position, East. Box 108, SCIENCE. X

Botanist, Ph.D. Morphology-anatomy major desires college teaching position. Experienced. Box 105, SCIENCE. 5/20

Microbiologist, Ph.D. Chemistry minor; 2 years of research; 4 years of college teaching. Male; age 36. Desires teaching or research position in West. Box 109, SCIENCE.

POSITIONS WANTED

(a) **Endocrine Physiology Ph.D.,** completing postdoctorate fellowship in enzyme biochemistry; military research in nuclear medicine and radiobiology; fellowships in muscular dystrophy and heart research; desires academic or research position. (b) **Bacteriology Ph.D.,** botany-chemistry minor; 3 years of university teaching and research experience; available for academic appointment. S5-2 Medical Bureau, Inc., Science Division, Burnside Larson, President, 900 North Michigan Avenue, Chicago. X

POSITIONS OPEN

Biostatistician Ph.D., research in child growth studies. Opportunities for varied consultation and teaching at dental school located in large medical center; modern computing facilities available. Salary from \$9000 and academic rank dependent upon qualifications. Write to Dr. Bhim Savara, Head of Department, Child Study Clinic, University of Oregon Dental School, 611 S.W. Campus Drive, Portland 1, Ore. X

GRADUATING? GRADUATED?
 YOUNG MAN, if you are committing yourself for employment you are definitely making one of the most important decisions in your life! Avoid the pitfall of accepting a position which will not make full use of your training and talents and will thereby obscure your career potential. Use our knowledge and experience. Our professional staff serve both the employee and employer to their mutual satisfaction by objectively and comparatively screening employer profiles and employee dossiers to properly place the man for the position. Send your inquiry and/or resumé to Doctor A. H. Hammond, Chairman, Liaison Committee, NATIONAL SCIENTIFIC PERSONNEL BUREAU, INC., 1029 Vermont Avenue, NW, Washington 5, D.C. X

Histologist, Histochemist, Ph.D. or equivalent. Research institute, New York. Modern, well equipped and staffed, air-conditioned laboratory. Opportunity for training in electron microscopy. Box 107, SCIENCE. 5/13, 20

POSITIONS OPEN

(a) **Biochemist** for new academic unit for coagulation and cardiovascular research opening in California; teaching and research duties. (b) **Epidemiologist** for foreign appointment with important industrial firm. (c) **Microbiologist** to conduct enzyme and fermentation research on agricultural and drug products; around \$10,000 a year; Midwest. (d) **Pharmaceutical Chemistry** faculty appointment; East. (e) **Research Scientists in Chemistry, Physiology, or Pharmacology** with radioisotope background for expanding nuclear science research firm; East. (f) **Zoology Assistant Professor** stressing ecology and biology; teaching with research opportunities; Chicago. (g) **Biochemist** with Ph.D. or M.S. degree and clinical experience for administrative duties in expanding hospital affiliated with leading medical school; Midwest. (h) **Assistant Research Director** with production experience to coordinate, supervise, and expedite clinical program of drug firm; Midwest. (i) **Physics/Mathematics Assistant or Associate Professor** for teachers college; East. (j) **Pharmacologist Group Leader** for cardiovascular research and supervising with drug firm; Midwest. (k) **Histologist, Ph.D.** or M.S. degree, experienced in preparing bone and periodontal tissue for research laboratory; Pacific Coast. (Please write for details; also many other positions available through our nationwide service.) S5-2 Medical Bureau, Inc., Science Division, Burnside Larson, President, 900 North Michigan Avenue, Chicago. X

Medical Technologist, blood banking background desirable. Interest in research required. Excellent opportunity to participate in blood group research. Salary open. Mail replies to R. F. Amelang, Milwaukee Blood Center, Inc., Milwaukee, Wis. ew

Position available in a **Geriatric Institute** to conduct and coordinate research. Applicant must have a Ph.D. degree or its equivalent. Salary commensurate with experience. Address inquiries to Institute of Geriatrics, 167 Street and Findlay Avenue, Bronx 56, N.Y., or call Dr. Seltzer or Dr. Klein at CYpress 3-1500. X

POSITIONS OPEN

ENDOCRINOLOGIST OR PHYSIOLOGIST

An expanding midwestern pharmaceutical company has an opportunity for a Ph.D. endocrinologist or physiologist with interest and experience in physiology of reproduction. Prefer 1 to 2 years postdoctoral industrial or academic experience. Position would involve basic and preclinical studies with sex hormones and related drugs.

Please send résumé to

Technical Employment Coordinator
THE UPJOHN COMPANY
Kalamazoo, Mich.

WARNER-LAMBERT RESEARCH INSTITUTE

MORRIS PLAINS, N. J.

Expanding research program offers opportunities for experienced

Ph.D. ORGANIC CHEMISTS
— Synthetic medicinals or natural products . . .

Ph.D. BIOCHEMISTS—Immunology Enzymes and Enzyme Metabolism . . .

PHARMACISTS — Development of Oral Products . . .

Ph.D. PHARMACOLOGIST—Cardio Vascular research . . .

Send Resume Stating
Salary Requirements to

WILLIAM J. SUMNER
WARNER-LAMBERT
RESEARCH INSTITUTE
Morris Plains, N.J.

(a) **Pharmacologist**, Ph.D., some medical courses; prefer teaching, research experience; \$10,000; midwestern pharmaceutical company. (b) **Chemist**, analytical or organic, for consulting firm engaged drug, protein, food evaluation, vitamin, hormone, toxicological assays; excellent equipment, facilities; midwestern university center. (c) **Biochemist**, Ph.D. to supervise biochemistry department and all laboratory personnel, about 30; 220-bed general hospital expanding this year; university, industrial center; Northcentral. (d) **Virologist-Tissue Culturist**, Ph.D. trained, experienced virus isolation, cell culture on tumor viruses; new building, newly organized eastern research group. (e) **Pharmacologist**, Ph.D., for animal experimentation, midwestern consulting firm. (f) **Biochemist**, Ph.D. to direct tissue culture laboratory, outstanding midwestern university medical school; to \$10,000. (Please write for analysis form. Our 64th year: Founders of the counselling service to the medical profession; serving medicine with distinction over half a century.) Science Division, Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash, Chicago. X

Science Teachers, Librarians, Administrators urgently needed for positions in many states and foreign lands. Monthly non-fee placement journal since 1952 gives complete job data, salaries. Members' qualifications and vacancies listed free. 1 issue, \$1. Yearly (11 issues) membership, \$5 individual; \$10 institutional. CRUSADE, SCI., Box 99, Station G, Brooklyn 22, N.Y. eow

Virologist (IVa) Ph.D., to head public health virus laboratory engaged in diagnostic and research activities. State civil service with retirement plan, plus social security. Starting salary \$8435 to \$10,774 maximum. Write Michigan Civil Service, Recruitment and Placement, Lansing 13, Mich., for further information. 5/6, 13, 20

POSITIONS OPEN

CHEMISTS CHEMICAL ENGINEERS

To 5 years experience in the following areas: Organic synthesis, polymer chemistry, applications, research and development in the general polymer field, including thermosetting, thermoplastic and elastomeric materials.

Also, Chemical Engineers for process development, bench and pilot plant operations, organic chemicals, resins and polymers; 0-2 years industrial experience.

Box 110, SCIENCE

Head of Physico-Neuro Pharmacology

Midwestern pharmaceutical firm seeks qualified man to head its Central Nervous Department. Age 30-45. Ph.D. or M.D. degree. Should have 5 years' experience in field with general knowledge and interest in neuropharmacology and neuroanatomy, experimental psychology, and pharmacology. Will have supervision responsibilities and broad decisions on various programs. Salary commensurate with experience. All replies confidential. Send résumé of education and experience to:

Box 111, SCIENCE

PESTICIDES RESEARCH

Canadian
Department of Agriculture
requires

Two Scientists to study insect physiology and the mode of action of fungicides.

Salary \$6360-\$7320

For details, write to

CIVIL SERVICE COMMISSION,
OTTAWA

Ask for Circular 60-550.

Research and Teaching Assistantships available for graduate students. Programs in metabolism, mechanism of biological reactions, muscle physiology, and enzyme chemistry. Stipends \$3000 per year. Applications invited for immediate consideration or for next academic year. Personal interviews arranged for promising candidates. Write to Chairman, Department of Pharmacology, St. Louis University School of Medicine, St. Louis 4, Mo. 5/13

FELLOWSHIPS

Predoctoral and Postdoctoral Fellowships in Medical Physics. Opportunities to do postgraduate work in the basic medical sciences and in their application to clinical problems. Emphasis is on the fields of radiation biology, radiation physics, and the clinical use of radioisotopes. Study programs leading to the M.S. and Ph.D. degrees and postdoctoral research supported by fellowships. Stipends vary with training and dependents. Write to Chairman, Department of Radiology, Medical Center, University of California, Los Angeles 24, Calif. X

The Market Place

BOOKS AND MAGAZINES

Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dep. A38, CANNER'S, Inc., Boston 20, Massachusetts

PROFESSIONAL SERVICES



LABORATORY SERVICES

for the
FOOD AND DRUG INDUSTRIES
Drug Evaluation, Food Additive Studies
Chemical and Biological Assays,
Clinical Studies, Research

LAWALL & HARRISON
Div. S. 1921 Walnut St., Philadelphia 3, Pa. LO 3-4322

SUPPLIES AND EQUIPMENT

YOU NEED THIS FREE CATALOG FOR YOUR FILES

Serums, antisera and bloods
of all kinds for technicians and tissue
culture laboratories. No salesman will call.

COLORADO SERUM CO.
4950 York St. • MAIN 3-5373 • Denver 16, Colo.

• HYPOPHYSECTOMIZED RATS

Shipped to all points via Air Express
For further information write
HORMONE ASSAY LABORATORIES, Inc.
8159 South Spaulding Ave., Chicago 29, Ill.

The Most Accurate Pipet

MISCO Micro pipets make measurements reproducible to 0.1% routinely. Most complete line anywhere. Write for catalog.

MICROCHEMICAL SPECIALTIES CO.

1825 Eastshore Highway, Berkeley 16, California

1919 - 1960
LaMotte Chemical
Chestertown, Maryland, U.S.A.
Specialists in

Colorimetric Techniques
Reagents-Standards-Comparators
Send for Illustrated
Controls Handbook Dept. H

"From the hand of the veterinarian
to research!"®



albino rats

CHARLES RIVER CD
(Caesarean derived)
CHARLES RIVER SD
(Sprague-Dawley descendants)
CHARLES RIVER W
(Wistar descendants)

HYPOPHYSECTOMIZED RATS

- Only Charles River CD animals used
- Rigidly controlled environment (same bldg.) birth to surgery.
- High speed surgery by graduate biologists.
- 10 years experience animal surgery.
- Overnight air service from Boston

THE CHARLES RIVER BREEDING LABS

Dept. B, 1093 Beacon Street, Brookline 46, Mass.
Henry L. Foster, D.V.M., President



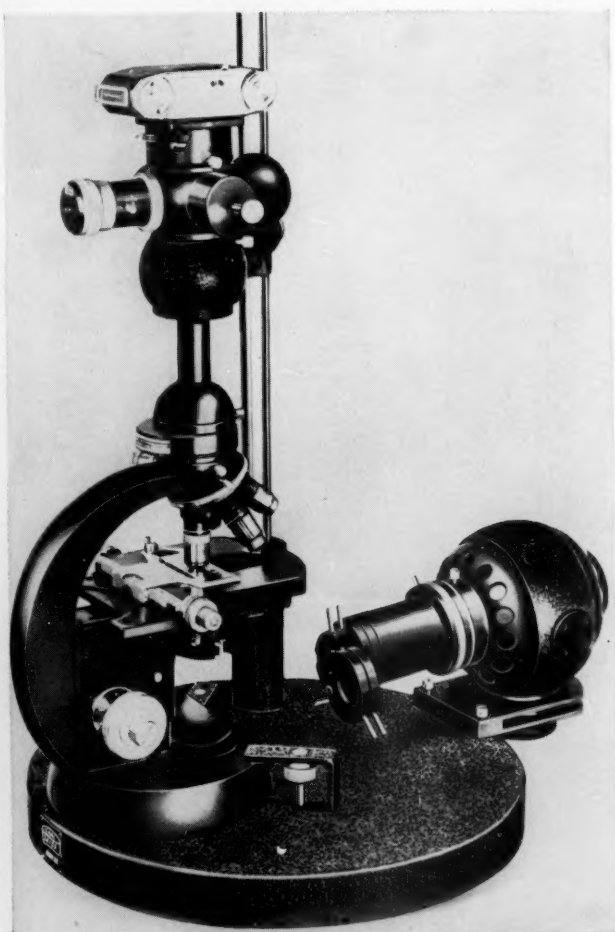
WEST GERMANY

Large Equipment for Fluorescence Microscopy

The Carl Zeiss Large Fluorescence Equipment fulfills to the highest degree the requirements of modern fluorescence microscopy in brightfield as well as dark-field.

Exciter filter combinations make it possible to select the most suitable ultra-violet or blue-violet range of the spectrum emitted by a high intensity mercury vapor burner. In addition, a specially designed filter tube, with rotatable disc containing barrier filters, not only protects the human eye but allows quick selection of filter combinations to obtain highest contrast of the specimens under examination. The purity of the produced fluorescence is not only of the optimum but of such high intensity that photomicrographs can be made in color or black-and-white.

Another outstanding advantage is the fact that every existing Carl Zeiss objective can be employed—not only Achromats but also highly corrected objectives such as Apochromats, Neofluars, and Planachromats. This makes it possible to observe true colors produced by fluorescence and at the same time makes the purchase of objectives suitable for fluorescence unnecessary.



Write for free, detailed literature

CARL ZEISS, INC.

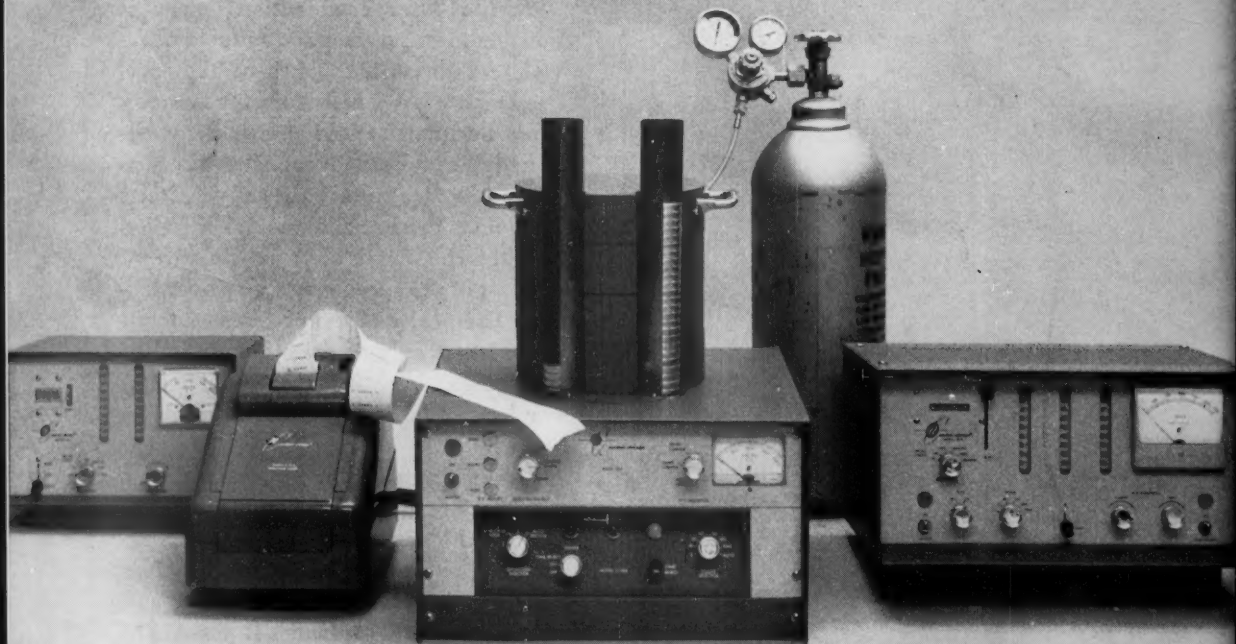
485 FIFTH AVENUE, NEW YORK 17, N. Y.

COMPLETE
SERVICE FACILITIES

Announcing a major breakthrough in automatic counting of solid radioactive samples.

Now samples containing minute, previously unmeasurable amounts of carbon-14, phosphorus-32, strontium-90, etc., can be counted automatically with high accuracy. A revolutionary new "guarded" Gas Flow Detector in the new Nuclear-Chicago Automatic Sample Changer has a net *background of only 2 counts per minute.*

The new system makes possible, for the first time, automatic analysis of beta samples having counting rates as low as 2-3 counts per minute. Measurement time is greatly reduced in routine sample counting, while the amount of radioactive reagent required in tracer experiments can be cut substantially.



For full information on the new Low Background Automatic Sample Changer, write for Bulletin C-115.


nuclear-chicago
CORPORATION
345 E. Howard Ave. • Des Plaines, Illinois

